Timeter RT-200

Calibration Analyzer

operation / service manual

RT-200
Calibration Analyzer
Operation/Service Manual

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BEFORE USING THE RT-200

1.1 INTRODUCTION

Thank you for purchasing the RT-200 Calibration Analyzer. This instrument will help you maintain and test many pieces of hospital equipment. It accurately measures pressure, gas flow rate, tidal volume, breath rate, inspiratory/expiratory ratio and other functions. The RT-200's micro-processor based design provides features and accuracy not available on other pneumatic calibrators. Features include peak-detect mode, digital display, self-diagnostics, and others. On many parameters, accuracy is 1% or better.

The RT-200 is designed with a light-weight, portable, modular case. The unit is easily transported anywhere you need to make precise measurements. With this one device you can perform calibrations, service and preventive maintenance on most Respiratory Therapy and related equipment. The RT-200 offers convenience, accuracy and flexibility in one small package.

This owner's manual provides the information you need to get the most benefit from your RT-200 Calibration Analyzer. Please take the time to read it thoroughly. If there is any way we can be of further service to you, please call Timeter at (800) 233-0258.

1.2 PRECAUTIONS

- DANGER, possible explosion hazard if used in the presence of flammable anesthetics.
- ELECTRICAL SHOCK HAZARD: Do not remove the cover. Refer servicing to qualified personnel only. Use only factory-approved parts and procedures to service this instrument.
- Grounding reliability can be achieved only when equipment is connected to a receptacle marked "HOSPITAL GRADE."
- DO NOT use power cord adaptor plugs.

1.3 CERTIFICATION & RECERTIFICATION

CERTIFICATION: Timeter Instrument Corporation certifies that this instrument has been thoroughly tested and inspected to meet its published specifications before being shipped from the factory. Enclosed are the results of this testing, showing the standard used during certification.

RECERTIFICATION: The recommended frequency of recertification is based on the frequency and type of use of the analyzer and the long-term stability of the internal electronic circuitry. As a general rule, the Timeter RT-200 should be tested and recertified every 12 months. To return your RT-200 to Timeter for recertification or factory service, follow the procedures in section 1.6 below, under the heading "CLAIMS, REPACKAGING AND FACTORY SERVICE." TO REDUCE DOWN TIME OF YOUR RT-200, CALL TIMETER CUSTOMER SERVICE IN ADVANCE TO SCHEDULE YOUR RECERTIFICATION.

1.4 INITIAL INSPECTION

Unpack the RT-200 Calibration Analyzer as soon as it is delivered. Save the box and packing for future shipping. Check the exterior of the unit for shipping damage. If there is exterior damage, DO NOT attempt to use the unit. Refer to the section below entitled "CLAIMS, REPACKAGING AND FACTORY SERVICE" (Section 1.6).

If there is no apparent damage, verify that the following items are included in the shipment:

A. Full Accessory Pouch (002-010) containing the following items:

		Part Number
1.	Two 24" lengths 3/16" ID vinyl tubing	911-003
2.	One 22mm ID x 22mm ID tubing adaptor	930-002
3.	One 22mm OD x 22mm OD tubing adaptor	930-003
4.	Two 22mm OD x 22mm ID x 3/16 ID tubing tee	930-004
5.	One 3/16" ID tubing tee	864-001
6.	One 1/4" ID tubing tee	002-007
7.	One 22mm ID x 3/16" ID tubing adaptor	930-001
8.	Two 1 Amp 3AG fuses or as appropriate for for line voltage being used	503-001
9.	Thumb nut	814-002B
10.	Nipple	843-119
11.	External Filter (includes: Adaptor 812-002 with screen 607-002)	

B. Dust Cover 602-003

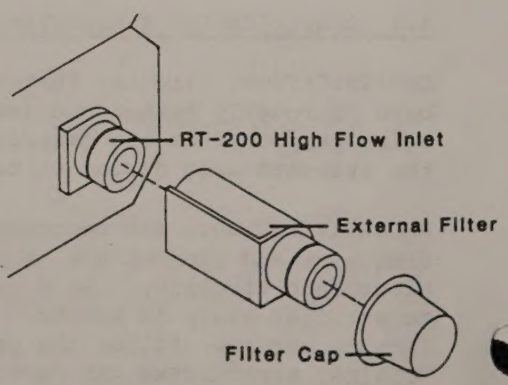
C. Any other items listed on the packing slip.

Notify Timeter is any of these items are missing.

*** IMPORTANT ***

An external filter is included in the RT-200 Accessory Pouch to prevent dirt from affecting the accuracy of the high flow transducer. Before making hook-ups to the high flow range port, attach this filter.

When the high flow range port is not being used the external filter can be left in place. Cover the filter and the high range outlet on the back of the unit with the caps provided to prevent dirt from entering.



1.5 FUNCTIONAL TEST

If the RT-200 passes the initial inspection, perform the following test to verify that it functions properly.

A. Attach the RT-200 power cord to a Hospital Grade Outlet.

B. Turn the RT-200 on. The power switch is located on the rear panel of the control module (Model RT-201).

C. After a few seconds this reading will appear on the display:

E _ _

If the RT-200 fails to perform this test or "HELP E" appears on the display, see Section 1.6 below entitled "CLAIMS, REPACKAGING AND FACTORY SERVICE."

1.6 CLAIMS, REPACKAGING AND FACTORY SERVICE

If the RT-200 does not pass initial inspection or fails the functional test, notify the Timeter Service Department at the telephone number listed below within 7 days and corrective action will be taken. Unless damage occured after delivery, Timeter will repair or replace your RT-200 without waiting for the claim against the carrier.

If your RT-200 malfunctions, or if you have trouble using it, refer to Appendix A entitled "TROUBLE SHOOTING." This section offers simple solutions to difficulties you may encounter. To resolve persistent problems, call Timeter at the number listed below and ask for the RT-200 Service Department.

When returning the RT-200 system to the factory for any reason, use the following procedure:

A. Call the factory to obtain return authorization.
B. Identify the unit to be returned to Timeter with a purchase order containing the name and address of the owner, the serial number and model number of the unit being returned and the specifics of the service required.
C. Carefully pack the unit in its original carton. If this carton is not available, call the Timeter Service Department for recommendations on suitable packing materials.
D. It is also recommended that you ship the unit fully insured. All shipments to Timeter must be prepaid. Shipping damage in transit to Timeter will be the responsibility of the customer.

Individual modules may be returned for service or recertication. Contact Timeter for details.

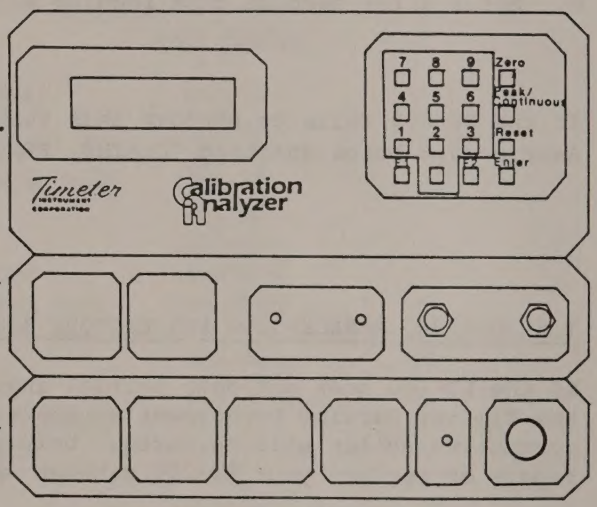
Refer other questions to Timeter at (800) 233-0258. IN Pennsylvania call COLLECT (717)-569-2695.

THEORY OF OPERATION

2.1 THE RT-200 SYSTEM

Figure 2.1 shows the "standard" RT-200. It consists of three modules: a Control Module and two "function" modules, flow and pressure, which maybe ordered seperately or as a system.

FIG.2.1



A. The Control Module (Model RT-201) is the "brain" of the RT-200, and controls all of its operations. The keypad and display are located on the Control Module.

B. The Pressure Module (Model RT-202) contains the transducers and circuitry for measuring various ranges of pressure and vacuum.

C. The Flow Module (Model RT-203) contains the transducers and circuitry for measuring gas flow rate. volumes, breath rate, inspiratory and expiratory times and I:E ratio.

The system can be expanded to include other modules as they become available.

2.2 THE CONTROL MODULE

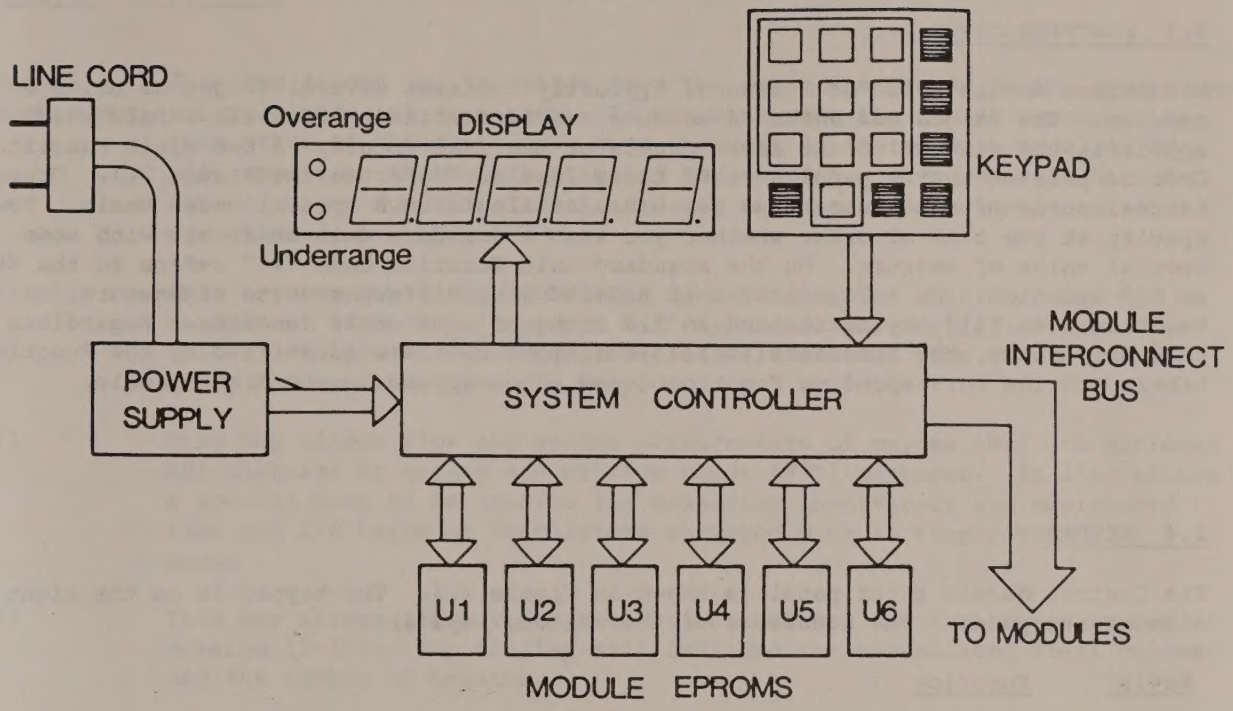
The Control Module performs two major tasks:

A. SELECTING FUNCTIONS: The Control Module allows you to select test functions. You do this by entering "Function Code" numbers on the keypad.
B. DISPLAYING READINGS: The Control Module computes test readings using information from the other modules and shows the result on the display.

The Control Module also:

- Supplies power to the other modules in the RT-200 system.
- Allows you to "Zero" test functions with the push of a button.
- Allows you to select "peak-detect" mode on many test functions.
- Shows you if a reading is overrange or underrange.
- Alerts you to various error conditions.

Figure.2.2



2.2.1 THEORY OF OPERATION - CONTROL MODULE

Figure 2.2 shows a block diagram of the Control Module (Model RT-201). The major component of the Control Module is the System Controller (Controller). The Controller is microprocessor-based and controls the operation of the system. The Keypad allows you to give commands directly to the Controller. For example; to measure air flow rate, you enter a code on the keypad which tells the Controller you want to use the air flow rate function. In response to this command, the Controller places a signal on the Module Interconnect Bus which activates the Flow Module. The transducers in the Flow Module convert gas flow rate to an electrical signal. The electrical signal is converted to digital form and sent to the Controller on the Module Interconnect Bus. The Controller analyzes this digital signal, computes the correct reading, and places it on the Display. The Module EPROMs contain specific data directing the Controller during signal processing. This data is placed in the EPROMs during factory calibration.

2.2.2 MODULE EPROMS

The Pressure and Flow modules (function modules) each have a Module EPROM which is installed on the Controller circuit board. (An EPROM is an integrated circuit which contains a computer program. The microprocessor in the Controller runs the program to control the RT-200's operations.) The Module EPROM must be properly installed for the associated function module to work. **DO NOT** remove or install EPROMs unless specifically instructed to do so by Timeter's Service personnel.

2.3 FUNCTION CODES

A function module (Flow or Pressure) typically contains several ranges or units of measure. The ranges and units of measure are identified by Function Labels which appear in the windows on the front panels of the each module. A two digit Function Code is printed on the panel next to these labels. Refer to the Figure 2.1. Other ranges, units of measure and and gases are available on a special order basis. You specify at the time of order whether you want a standard unit or a unit with some special units of measure. On the standard unit Function Code "11" refers to the 20 cm H2O function. On a "special" unit ordered with different units of measure, Function Code "11" may correspond to 7.2 in Hg or some other function. Regardless of this difference, the functions available on your unit are identified by the Function Labels and the corresponding Function Codes which appear on the front panels.

2.4 KEYPAD

The Control Module front panel is shown in Figure 2.3. The keypad is on the right side of the panel. The functions of the various keys are:

Key(s)	Function
0 - 9	Used to enter Function Codes
Enter	After you type in a two-digit Function Code, pressing the Enter key causes the RT-200 to activate the desired function.
Zero	"Zeros" the display to compensate for any drift that occurs. When "zeroing", REMOVE ALL ALL CONNECTIONS FROM THE FUNCTION INLET FITTINGS. While the unit is "zeroing", the Controller tests the display by lighting all the segments in the display. After a second, a value of zero will appear on the display, indicating the RT-200 is ready to continue operation. The zero values are stored as long as the RT-200 remains powered up. If the unit is turned off or power is interrupted, they are lost. When the the RT-200 is turned on you will need to "zero" the functions you want to use. If you attempt to use a function which has not been zeroed, the Controller will place the following indication on the display:

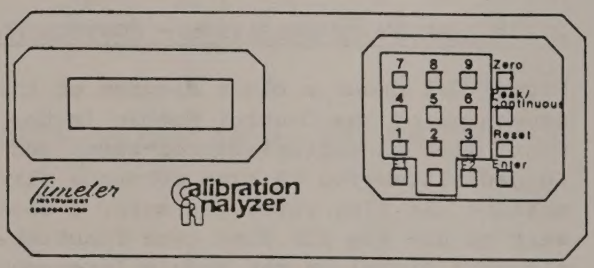


Figure 2.3

oooo o

Press the Zero key to set the zero value. It is a good practice to re-zero the RT-200 just before critical measurements. If special functions or triggering options are selected, these will be briefly displayed after the Zero key is pressed. (see below)

Key(s)	Function
Peak/ Continuous	This key allows you to switch from the peak-detect mode to the continuous (normal) mode and then back. In the Peak mode the RT-200 measures the peak value of the function. When the unit is in the Peak mode, a "P" will appear on the Mode section of the display. This key will have no effect when a function is selected for which peak-detect mode is not operational.
Reset	This key instructs the CONTROLLER to return to the initial power-up condition. The "E _ _" prompt will appear on the display. Zero offset values and special functions selected will remain. The RT-200 is now ready for commands from the keypad.
F1	This key allows flow and volume measurements of oxygen (02) and nitrogen N2) mixtures or oxygen and nitrous oxide (N2O) mixtures. It also allows a special mode to be entered for measuring inspiratory and expiratory time and I/E ratio on ventilators equipped with an inspiratory hold mode.
F2	This key allows tidal volumes to be accumulated for a selected number of breaths (2-10). The display will indicate the accumulated tidal volume and the number of breaths.
0 0	This is a special function that allows you to make corrections for gas pressure, temperature and humidity so that test results of flow and volume can be displayed in ATP, STP or BTPS units.

ATP: (ambient temperature and pressure) At power up the RT-200 defaults to ATP, assuming the temperature of the test gas is 70° F. If it is not, USE the ATP mode of the "0 0" function to enter the actual test gas temperature. This is helpful when testing devices that are calibrated in ATP

STP: (standard temperature and pressure) This corrects measurements to standard temperature (70° F) and standard pressure (760mm Hg). In this mode barometric pressure must be entered so the RT-200 can make necessary corrections. The RT-200 compensates for gas pressure, but gas temperature must be between 59-95°F. See note below.

BTPS: (body temperature, 98.6°F and ambient pressure, saturated with water vapor) allows testing to be done using DRY gas from an oxygen cylinder (on oxygen ranges) or an existing humidity air source (on air ranges) and corrects the gas flow/volume to it equivalent BTPS reading. This is useful because **BTPS gas MUST NEVER be allowed to flow through the RT-200** or it will be damaged. The gas temperature must be between 59-95°F.

NOTE: The RT-200 allows gas temperature to vary between 59-95°F, however, maximum accuracy is achieved using 70°F dry oxygen or 70°F 20% RH air.

Key(s)	Function

0 1 This is a special function that allows you to modify the duration of the start and end-of-breath delays and the sensitivity of the triggering level. It applies to all measurements triggered by the start/stop of flow or pressure (see NOTE below). It can be useful in special circumstances where pnuematic noise, waveform ringing and overshoot cause false triggering.

CAUTION: This function should not be used to allow malfunctioning equipment to pass testing. Investigate and solve any abnormal pnuematic noise (leaky ventilator valves, poor test set-up, etc.) before using the "0 1" function.

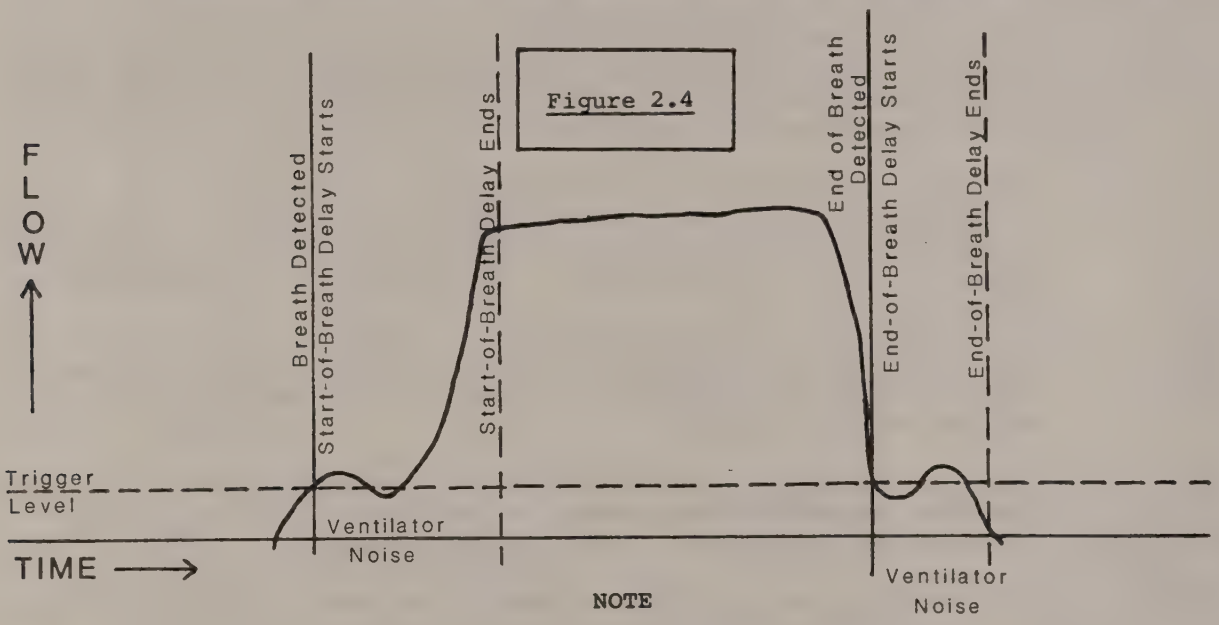


Figure 2.4

NOTE

The start of the breath is sensed when the flow reaches 1% of the full scale of the function being used (the triggering level can be raised to 4%). The RT-200 ignores valve noise for the first .05 second after the breath is sensed. This .05 second period is the built-in "start-of-breath delay." If the valve noise is still present at the end of the breath delay, the RT-200 will show a "HELP r" message on the display. Then it automatically "tries again" in case the problem was caused by a vibration in the test set-up or other irregularities. The "HELP r" message is also displayed if the breath delay is longer than the inspiratory time.

Likewise, the end of the breath is sensed when the flow drops to 1% of the full scale of the function being used (trigger level can be raised to 4%). The RT-200 ignores valve noise for the first .100 second after the breath ends. This .100 second period is the built in "end-of-breath delay." If the valve noise is still present after the end-of-breath delay, the RT-200 will show a "HELP F" message on the display. Then it automatically "tries again" in case the problem was caused by a vibration in the test set-up or other irregularities. The "HELP F" message is also displayed if the end-of-breath delay is longer than the expiratory time.

Likewise, when a peak pressure is selected, the trigger level is set at approximately 1% of the full scale of the function selected. On both peak flow and pressure, any peaks during the start-of-breath delay are ignored. On all other functions, data collection starts immediately with the start of the breath.

Key(s)	Function
0 9	Returns the special functions to power up conditions without losing zero values. To use press the 0 key and 9 key and press enter.

2.4.1 Application of Special Functions

The special functions apply to the test functions indicated in Figure 2.5.

Figure 2.5

◯ = AVAILABLE Ⓟ = AVALIABLE IN PEAK ONLY

SPECIAL FUNCTION	KEY(S)	PRESSURE	FLOW (LOW & HIGH)				TIDAL VOLUME		MINUTE VOLUME		TIME			
		ALL	AIR	O2	N2O	SPEC	AIR	O2	AIR	O2	BPM	TINSP	TEXP	I/E RATIO
O2/N2 MIXTURES	F1			◯				◯		◯				
O2/N2O MIXTURES	F1				◯									
HOLD MODE	F1											◯	◯	◯
ACCUMULATIVE VOLUME	F2						◯	◯						
ATP, STP, BTPS	0 + 0		◯	◯	◯	◯	◯	◯	◯	◯				
BREATH DELAYS, START & END-OF-, & TRIGGER LEVEL	0 + 1	Ⓟ	Ⓟ	Ⓟ	Ⓟ	Ⓟ	◯	◯	◯	◯	◯	◯	◯	◯

2.5 SELECTING A FUNCTION

There are four ways to select a function:

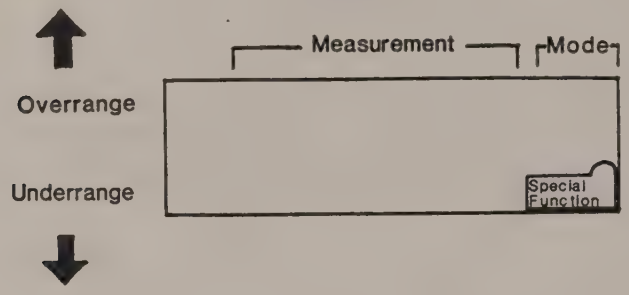
A. **Enter the FUNCTION CODE, then press the Enter key.** The CONTROLLER will select the function, but will not save a "zero value." The previous value (if there is one) will be used to compute new readings on the display. If no "zero value" was stored for this function, the CONTROLLER will place the "oooo o" message on the display.

B. **Enter the FUNCTION CODE, then press the Zero key.** The CONTROLLER will select the function and immediately save a "zero value." The advantage of this method is that the function is entered and zeroed with one keystroke.

C. **Enter the FUNCTION CODE, then press the Peak/Continuous key.** The CONTROLLER will select the function and immediately switch into peak-detect mode if it is allowable. No zero operation will be performed.

D. **Enter the first digit of the FUNCTION CODE, then press the Zero key.** Enter the second digit of the FUNCTION CODE and press the Peak/Continuous key. The CONTROLLER will select the function, immediately save a "zero value", and switch to peak-detect mode if it is available for that function. The outcome will be the same if the order of the Zero and Peak/ Continuous keys is reversed in this description.

Figure 2.6



2.6 DISPLAY

The RT-200 display consists of three sections. These sections are shown in Figure 2.6 and are explained below:

A. OVERRANGE AND UNDERRANGE INDICATORS: These are located directly to the left of the display. They indicate whether a display reading is outside of the accurate range on the RT-200.

The overrange lamp lights when the display reading exceeds the normal accurate range of the function selected. Readings taken when the overrange lamp is lit may be inaccurate. If the reading continues to rise, a point will be reached where the display will blank, and the overrange lamp will still be lit. This is called the "blanking point." This feature prevents the RT-200 from displaying readings which may be greatly inaccurate. The amount by which the "blanking point" exceeds the top of the range varies with each function and is listed on the individual function specification sheets included with this manual.

The underrange lamp lights when the display reading goes below negative ten or a reverse flow exists. Negative readings, down to -10, are displayed with a minus sign in the mode section of the display.

B. MEASUREMENT: This four-digit section of the display normally contains the measurement. Self-diagnostic messages may also appear in this section. See section 2.7 below for a list of the possible readings and messages which may appear on the display.

C. MODE: See section 2.7 for a list of the symbols which may appear in the mode section of the display.

2.7 POSSIBLE DISPLAY MESSAGES

This section lists the possible readings, codes and messages which may appear on the display. "123" is used to represent any numeric reading, X is used to represent a number from 1 to 9 or a letter.

DISPLAY	MEANING
E _ _	This is the keypad entry prompt. The CONTROLLER is waiting for you to type in a function code or some other command.
oooo o	Indicates that a function you have selected needs to be "zeroed" before readings can be taken.
0.01 -	A "minus" sign in the mode section indicates a reading below zero.
1.23 P	Indicates that the RT-200 is in peak-detect mode. The reading will not change until another peak is encountered.
1-2.3	I:E ratio reading.
° 100.3	Overrange lamp lit indicates a reading above the upper limit of the function.
°	Overrange lamp lit with blank display indicates that the reading is beyond the upper limit of the function.
° <	Underrange lamp lit with blank display indicates that the reading is more than 10 below zero.
HELP X	This is a "HELP message. It indicates that an error condition has been encountered. See page 5.1 for a list of the "HELP" messages and their meanings.
. 1.23	Underrange lamp with display reading indicates that flow or peak pressure is occuring in a negative direction. The display indicates the last valid, positive reading.
100.3 .	Indicates a special function has been selected.
E _ _ P	Indicates that the Peak/Continuous key was pressed before the full FUNCTION CODE was entered. The CONTROLLER will place the RT-200 in peak-detect mode as soon as you enter the FUNCTION CODE and press the Enter key.

2.8 SPECIFICATIONS

Dimensions: 31 W x 26 H x 29 D (centimeters)
12 W x 10-1/2 H x 11-1/2 D (inches)

Mass: 7 kg (15-1/2 lbs.)

Power Requirements: 115 VAC ± 10%, 47-440 Hz, 0.5 amp

Other power supply configurations available:

100 VAC ± 10%	47-440 Hz
220 VAC ± 10%	47-440 Hz
230/240 VAC ± 10%	47-440 Hz

Operating Conditions:

Temperature:	10 to 40° C (50 to 104° F)
Humidity:	20-80% RH

Storage Conditions:

Temperature:	-30 to 60° C (-22 to 140° F)
Humidity:	10-90% RH

Power Cord: 3 m (10.6 ft.) with hospital grade plug

PRESSURE MODULE OPERATION

3.1 SET-UP PROCEDURE

(Skip Section 3.1 if your RT-200 is already powered and warmed up.)

A. Connect the RT-200 power cord to a standard hospital grade outlet.

B. Turn on the power. The power switch is located on the rear of the Control Module. After a few seconds, the indication "E _ _" will appear on the display.

C. Allow the RT-200 to warm up for about five minutes. If you take readings immediately after power up, they may be outside the normal accuracy limits of the RT-200.

3.2 OPERATION (Measuring Pressure)

A. Decide which function you wish to use.

B. Find the label for that function. The functions available on your RT-200 are identified by the FUNCTION LABELS which appear in the windows of each module.

C. Find the FUNCTION CODE. This is the two-digit number next to each FUNCTION LABEL.

D. Enter the FUNCTION CODE on the keypad. For example, to enter FUNCTION CODE "12" press the "1" key and then press the "2" key. If you make a mistake, press the Reset key and re-enter the FUNCTION CODE. As you press each digit of the FUNCTION CODE, you will see the digit appear on the display.

E. Press the Enter key. The lamp next to the FUNCTION LABEL will light, indicating that the function is selected.

F. If the indication "oooo o" appears on the display, "zero" the function. Use the following procedure to zero a function:

1. Disconnect all tubing attached to the pressure inlet fittings or turn off the pressure source and vent to atmospheric pressure. The function can only be properly "zeroed" if there is no pressure applied to the inlet fittings.
2. Press the zero key. All the segments of the display will light briefly, and then a reading of zero will appear.

G. Determine whether the function you have selected is a low range pressure or a high range pressure.

1. Low Range pressures have FUNCTION CODES 11-14 and are bordered in black. The inlet fittings you should use for low range pressures are marked "LOW PRESSURE RANGE," and are also bordered in black.

2. High Range pressures have FUNCTION CODES 21-24, and are bordered in ivory. The inlet fittings you should use for high range pressures are marked "High Range" and are also bordered in ivory.

H. Connect the tube to the correct inlet fittings. Connect tubing containing positive pressures to the appropriate "P+" inlet fitting. Connect tubing containing negative pressure (vacuum) to the appropriate "P-" inlet fitting.

I. Apply pressure.

J. Read the display. The correct reading will now appear on the display. Pressures beyond the range of the selected function will light the overrange lamp on the display. If the underrange lamp lights, verify that you have made the tubing connections to the correct inlet fitting.

K. Check the zero periodically. Follow this procedure to check the zero:

1. Remove the tubing from the inlet fittings you are using or turn off the pressure source and vent to atmospheric pressure.
2. Check the display reading. If the display does not read zero, press the Zero key on the keypad. The display will now read zero. Resume testing.

L. To use the peak-detect mode, press the Peak/Continuous key on the keypad. A "P" will appear on the mode section of the display. This indicates that the RT-200 is in peak-detect mode. The unit will now display peak pressure readings as they occur. To return to continuous mode, press the Peak/Continuous key again. The "P" will disappear from the mode section of the display. The RT-200 will now display normal continuous readings of the pressure.

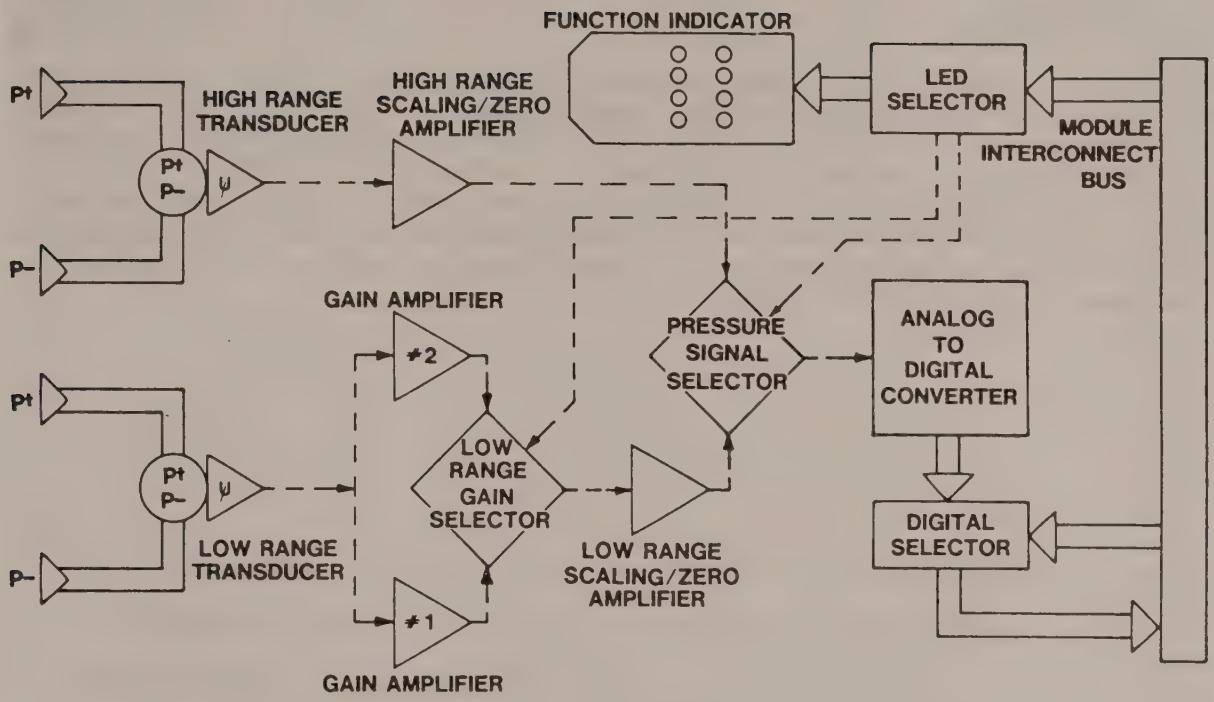
3.2.1 SELECTING A DIFFERENT FUNCTION

To select a different function follow the procedures above, Section 3.2.

3.3 THEORY OF OPERATION

This section refers to the Pressure Module block diagram below (Figure 3.1). The Pressure Module contains two independent differential pressure transducers. These transducers convert pressure to electrical signals. The signal from the High Range Transducer is conditioned by the High Range Scaling/Zero Amplifier, and proceeds to the Pressure Signal Selector. The signal from the High Range Transducer passes into Gain Amplifiers 1 & 2. These amplifiers provide the module with two different sensitivity ranges for the Low Range Transducer. The Low Range Gain Selector chooses the appropriate signal based on data sent from the System Controller in the Control Module. The Low Range Scaling/Zero Amplifier conditions the selected signal and sends it to the Pressure Signal Selector. A data line from the Controller directs the Pressure Signal Selector. The Analog To Digital Converter converts the selected signal to digital form. The digitized signal is placed onto the Module Interconnect Bus for further processing by the Controller. The Controller also sends data to the LED Selector, which lights the appropriate lamp on the Function Indicator circuit board.

Figure 3.1



3.3.1 PRESSURE TRANSDUCER INDEPENDENCE

The two transducers in the Pressure Module operate independently. Readings on the range you are using will not be affected by pressure applied to the inlet fittings of the other range. For example, if you are monitoring a pressure using the 250 cm H2O range, you can attach pressure lines to the high range inlet fittings without affecting the readings on the display. In the same manner, pressure applied to the low range inlet fittings will not affect measurements you take on the high range functions.

This feature allows you to monitor two different pressures by alternately selecting one then the other. You must remember not to "zero" a function while pressure is applied to its inlet fittings. A "HELP" message may appear on the display if you attempt to zero a function when pressure is applied. See page 5-1 for information on "HELP" messages.

The pressure module is also independent of other modules in the RT-200 system. Readings taken on the Pressure Module will not be affected by flows or other parameters applied to different Function Modules. In the same way, a function you are using on another module will not be affected by pressures connected to the inlet fittings of the Pressure Module. This allows you to monitor several different functions simultaneously. For instance, flow and pressure can be monitored at the same time to perform a bacteria filter test. Selecting two functions alternately offers you a way to measure back pressure while maintaining a known flow rate through the bacteria filter.

3.3.2 TARE WARNING

DO NOT use the Zero key as a "Tare" function. It is possible to press the Zero key with a small amount of pressure applied and have the CONTROLLER consider this input as a new "zero." Deviations from this reference pressure will then appear as small positive or negative readings on the display. However, this procedure will lead to inaccurate readings because of the transducer linearization technique used in the RT-200. This technique assumes that the "zero value" measured when the Zero key is pressed corresponds to no pressure. When this assumption is not true, incorrect linearization and inaccurate readings will result.

11 20 cm H20

RT-200 INSPECTION

INSPECTOR: JAY
SERIAL # M15P

TEMPERATURE 21
DATE: 11/03/87

INPUT	RT-200	ERROR
10.160	10.16	0.000
12.700	12.70	0.000
15.240	15.24	0.000
17.780	17.79	0.010
20.320	20.34	0.020

ACCURACY:
+/- 1 % OF READING OR +/- 2 DIGIT(S) (WHICHEVER IS GREATER) AT 70 F

+/- 2 % OF READING OR +/- 2 DIGIT(S) (WHICHEVER IS GREATER) AT 15-35 C

OVERRANGE BLANKING POINT 24.00

STANDARD CODE FOR COMPUTER INTERFACE: 24

DISPLAY UPDATE RATE: 1 PER SECOND

PEAK DETECT MODE AVAILABLE ON THIS FUNCTION

TEST REFERENCE:
MANSFIELD AND GREEN MODEL PK OR RK DEAD WEIGHT TESTER
(.05% OF READING)

3.3.2 TARE WARNING

DO NOT use the Zero key as a "Tare" function. It is possible to press the Zero key with a small amount of pressure applied and have the CONTROLLER consider this input as a new "zero." Deviations from this reference pressure will then appear as small positive or negative readings on the display. However, this procedure will lead to inaccurate readings because of the transducer linearization technique used in the RT-200. This technique assumes that the "zero value" measured when the Zero key is pressed corresponds to no pressure. When this assumption is not true, incorrect linearization and inaccurate readings will result.

11 20 cm H20

RT-200 INSPECTION

INSPECTOR: JAY
SERIAL # M15P

TEMPERATURE 21
DATE: 11/03/87

INPUT	RT-200	ERROR
10.160	10.16	0.000
12.700	12.70	0.000
15.240	15.24	0.000
17.780	17.79	0.010
20.320	20.34	0.020

ACCURACY:
+/- 1 % OF READING OR +/- 2 DIGIT(S) (WHICHEVER IS GREATER) AT 70 F

+/- 2 % OF READING OR +/- 2 DIGIT(S) (WHICHEVER IS GREATER) AT 15-35 C

OVERRANGE BLANKING POINT 24.00

STANDARD CODE FOR COMPUTER INTERFACE: 24

DISPLAY UPDATE RATE: 1 PER SECOND

PEAK DETECT MODE AVAILABLE ON THIS FUNCTION

TEST REFERENCE:
MANSFIELD AND GREEN MODEL PK OR RK DEAD WEIGHT TESTER
(.05% OF READING)

12 250 cm H20 RT-200 INSPECTION

INSPECTOR: RES
SERIAL # M15P

TEMPERATURE 21
DATE: 11/03/87

INPUT	RT-200	ERROR
12.70	12.7	0.00
25.40	25.4	0.00
38.10	38.1	0.00
50.80	50.8	0.00
101.60	101.6	0.00
152.40	152.4	0.00
203.20	203.2	0.00
254.00	254.1	0.10

ACCURACY:
+/- .5 % OF READING OR +/- 2 DIGIT(S) (WHICHEVER IS GREATER) AT 70 F

+/- 1.5 % OF READING OR +/- 2 DIGIT(S) (WHICHEVER IS GREATER) AT 15-35 C

OVERRANGE BLANKING POINT 300.0

STANDARD CODE FOR COMPUTER INTERFACE: 20

DISPLAY UPDATE RATE: 1 PER SECOND

PEAK DETECT MODE AVAILABLE ON THIS FUNCTION

TEST REFERENCE:
MANSFIELD AND GREEN MODEL PK OR RK DEAD WEIGHT TESTER
(.05% OF READING)

13 185 mm HG RT-200 INSPECTION

INSPECTOR: RES
SERIAL # M15P

TEMPERATURE 21
DATE: 11/03/87

INPUT	RT-200	ERROR
9.30	9.3	0.00
18.70	18.7	0.00
28.00	28.0	0.00
37.40	37.4	0.00
74.70	74.7	0.00
112.10	112.1	0.00
149.50	149.5	0.00
186.80	186.9	0.10

ACCURACY:
+/- .5 % OF READING OR +/- 2 DIGIT(S) (WHICHEVER IS GREATER) AT 70 F

+/- 1.5 % OF READING OR +/- 2 DIGIT(S) (WHICHEVER IS GREATER) AT 15-35 C

OVERRANGE BLANKING POINT 222.0

STANDARD CODE FOR COMPUTER INTERFACE: 23

DISPLAY UPDATE RATE: 2 PER SECOND

PEAK DETECT MODE AVAILABLE ON THIS FUNCTION

TEST REFERENCE:
MANSFIELD AND GREEN MODEL PK OR RK DEAD WEIGHT TESTER
(.05% OF READING)

21 20 psi RT-200 INSPECTION

INSPECTOR: JAY
SERIAL # M15P

TEMPERATURE 21
DATE: 11/03/87

INPUT	RT-200	ERROR
2.000	2.00	0.000
4.000	4.01	0.010
6.000	6.01	0.010
8.000	8.01	0.010
11.000	11.02	0.020
14.000	14.02	0.020
17.000	17.02	0.020
20.000	20.03	0.030

ACCURACY:
+/- .5 % OF READING OR +/- 2 DIGIT(S) (WHICHEVER IS GREATER) AT 70 F

+/- 1.5 % OF READING OR +/- 2 DIGIT(S) (WHICHEVER IS GREATER) AT 15-35 C

OVERRANGE BLANKING POINT 24.00

STANDARD CODE FOR COMPUTER INTERFACE: 2D

DISPLAY UPDATE RATE: 1 PER SECOND

PEAK DETECT MODE AVAILABLE ON THIS FUNCTION

TEST REFERENCE:
MANSFIELD AND GREEN MODEL PK OR RK DEAD WEIGHT TESTER
(.05% OF READING)

22 100 psi RT-200 INSPECTION

INSPECTOR: JAY
SERIAL # M15P

TEMPERATURE 21
DATE: 11/03/87

INPUT	RT-200	ERROR
5.00	5.0	0.00
10.00	10.0	0.00
20.00	20.0	0.00
30.00	30.0	0.00
50.00	50.1	0.10
60.00	60.0	0.00
80.00	80.0	0.00
100.00	100.0	0.00

ACCURACY:
+/- .5 % OF READING OR +/- 1 DIGIT(S) (WHICHEVER IS GREATER) AT 70 F

+/- 1.5 % OF READING OR +/- 1 DIGIT(S) (WHICHEVER IS GREATER) AT 15-35 C

OVERRANGE BLANKING POINT 101.0

STANDARD CODE FOR COMPUTER INTERFACE: 28

DISPLAY UPDATE RATE: 2 PER SECOND

PEAK DETECT MODE AVAILABLE ON THIS FUNCTION

TEST REFERENCE:
MANSFIELD AND GREEN MODEL PK OR RK DEAD WEIGHT TESTER
(.05% OF READING)

23 5170 mm HG RT-200 INSPECTION

INSPECTOR: JAY
SERIAL # M15P

TEMPERATURE 21
DATE: 11/03/87

INPUT	RT-200	ERROR
259.0	258	-1.0
517.0	518	1.0
1034.0	1035	1.0
1551.0	1553	2.0
2586.0	2589	3.0
3103.0	3106	3.0
4137.0	4141	4.0
5171.0	5175	4.0

ACCURACY:
+/- .5 % OF READING OR +/- 1 DIGIT(S) (WHICHEVER IS GREATER) AT 70 F

+/- 1.5 % OF READING OR +/- 1 DIGIT(S) (WHICHEVER IS GREATER) AT 15-35 C

OVERRANGE BLANKING POINT 5220

STANDARD CODE FOR COMPUTER INTERFACE: 2C

DISPLAY UPDATE RATE: 1 PER SECOND

PEAK DETECT MODE AVAILABLE ON THIS FUNCTION

TEST REFERENCE:
MANSFIELD AND GREEN MODEL PK OR RK DEAD WEIGHT TESTER
(.05% OF READING)

FLOW MODULE OPERATION

4.1 SET-UP PROCEDURE

(Skip Section 4.1 if your RT-200 is already powered and warmed up.)

A. Connect the RT-200 power cord to hospital grade outlet.

B. Turn on the power. The power switch is located on the rear of the Control Module. After a few seconds, the indication "E _ _" will appear on the display.

C. Allow the RT-200 to warm up for about five minutes. If you take readings immediately after power up, they may be outside the normal accuracy limits of the RT-200.

4.2 OPERATION (Measuring Flow)

A. Decide which function you wish to use.

B. Find the label for that function. The functions available on your RT-200 are identified by the Function Labels which appear in the windows of each module.

C. Find the Function Code. This is the two-digit number next to each Function Label.

D. Enter the Function Code on the keypad. For example, to enter Function Code "35" press the "3" key and the press the "5" key. If you make a mistake, press the Reset key amd re-enter the Function Code. As you press each digit of the Function Code, you will see the digit appear on the display.

E. Press the Enter key. The lamp next to the Function Label will light, indicating that the function is selected.

F. If the indication "oooo o" appears on the display, "zero" the function. Use the following procedure to zero the function:

1. Disconnect all tubing attached to the flow inlet fittings or turn off the flow source. The function can only be properly "zeroed" if there is no flow passing into the inlet fittings.
2. Press the Zero key. All the segments of the display will light briefly and then a reading of zero will appear.

G. Determine whether the function you have selected is a high range flow rate or a low range flow rate.

1. Low range flow rates have Function Codes 31-34, and are bordered in black. The flow inlet you should use for low range flow rates is marked "Low Range," and is also bordered in black.
2. High range flow rates have Function Codes 35-38, and are bordered in ivory. The flow inlet you should use for high range flow rates is marked "High Range," and is also bordered in ivory.

H. Connect the tubing to the correct flow inlet.

WARNING: DO NOT measure low range flow rates while flow is passing into the high flow range inlet. False low readings of low range functions will result.

I. Apply the flow, using clean, dry gas only.

J. Read the display. The correct flow readings will now appear on the display. Flow rates beyond the range of the function you have selected will light the overrange lamp on the display. If the underrange lamp lights, verify that you have applied the flow to the correct inlet fitting.

K. Check the zero periodically. Follow this procedure to check the zero.

1. Remove the tubing from the flow inlet fitting you are using.
2. Check the display reading. The display should read zero.
3. If the display does not read zero, press the Zero key on the keypad. The display will now read zero.
4. Resume testing.

L. To use the peak-detect mode, press the Peak/Continuous key on the keypad. A "P" will appear on the mode section of the display. This indicates that the RT-200 is in peak-detect mode. The unit will now display peak flow readings as they occur. To return to continuous mode, press the Peak/Continuous key again. The "P" will disappear from the display. The RT-200 will now display normal readings of the flow rate.

4.3 HOW TO MEASURE TIDAL VOLUME

A. (Enter the FUNCTION CODE as outlined in Section 4.2) Connect the tubing to the high flow range inlet.

B. Apply the flow. Cycle your ventilator or other volume producing device.

C. Read the display. The correct tidal volume will appear on the display at the end of each breath.

NOTE: The peak-detect mode is not available on the tidal volume functions. If you press the Peak/Continuous key nothing will happen.

D. Rezero the unit periodically, following this procedure:

1. Remove any tubing connected to the high flow inlet or turn off the flow source.
2. Press the Zero key on the keypad and resume testing.

E. A test lung may be used on the rear of the RT-200's high flow element , but readings will show a very slight error due to the "back pressure" introduced by the test lung. If you wish to correct this error, see section 4.10.7. Check the ventilator manufacturer's manuals to see what effect the test lung will have on the ventilator output. Whenever a test lung is connected, make sure it is not deflating during the zeroing process or a false zero will be stored.

4.4 MEASURING FLOWS OF OXYGEN/NITROGEN AND OXYGEN/NITROUS OXIDE MIXTURES AND VOLUMES OF OXYGEN/NITROGEN MIXTURES

(See CAUTION below)

A. Enter and zero any FUNCTION CODE corresponding to O2/N2 or O2/N2O mixtures (Enter the code the same as outlined in Section 4.2).

B. Press the F1 key on the keypad. The O2 percentage being tested will appear on the display. (On power up, the O2 percentage defaults to 100% on O2/N2 mixtures and 0% on O2/N2O mixtures.

C. To change the O2 percentage to the value of the gas mixture you are testing, enter the percentage (0-100) using the numeric keys on the keypad and press the Enter key. (Three digits must be entered. Ex: enter 022 for 22%.) If the value is not entered properly, the last allowable value or the default value will be displayed. If so, repeat this step.

D. Determine whether the FUNCTION CODE you have selected is in the high or low flow range and connect tubing to the appropriate inlet fitting (See Section 4.2 Steps G and H).

E. Apply the flow using clean dry gas. The corrected reading will appear on the display.

F. Check the "zero" periodically (See Section 4.2 Step K).

NOTE: When you enter an O2 percentage into a FUNCTION CODE, it is automatically entered into the other FUNCTION CODES for that same mixture. For instance: If you enter 22% (022) into the low flow O2/N2, the high flow O2/N2 and the O2/N2 volume functions will also be entered at 22%. To remind you of this, the O2 concentration (as well as any other special function entered) is momementarily displayed when you enter a FUNCTION CODE of the same mixture. To check what special functions are in effect at any time during operation, simply press the Enter key.

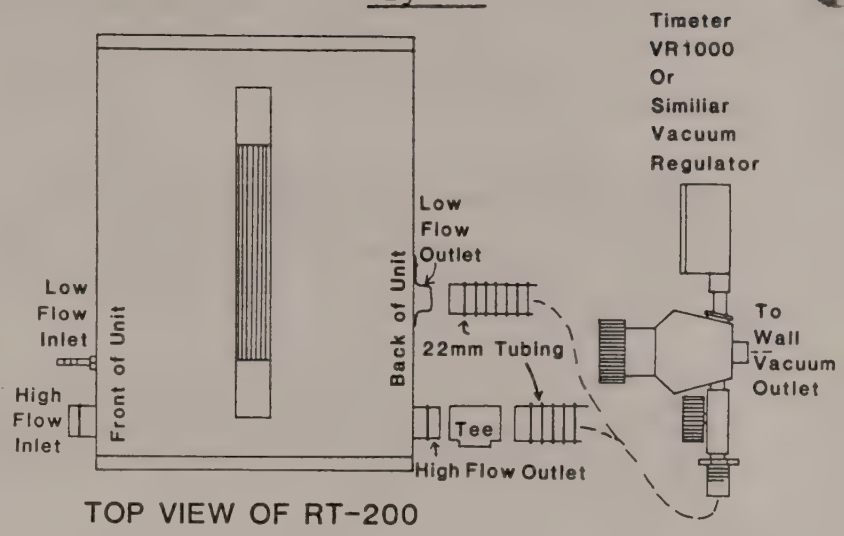
CAUTION

Long term exposure to moderate levels of nitrous oxide is suspected to adversely affect decision-making ability. NIOSH, the research arm of the Occupational Safety and Health Administration (OSHA), recommends that maximum exposure level should not exceed an eight-hour, time-weighted average of 25 parts per million. Although OSHA does not publish a requirement for nitrous oxide exposure Timeter recommends adherence to the NIOSH limit given above.

For this reason, Timeter has designed a nitrous oxide scavenging system that should be used whenever nitrous oxide flow rates are measured with an RT-200. The instructions below will show you how to use your hospital vacuum source to vent nitrous oxide out of your work area.

High Flow Measurements (0-20 lpm N2O)

Fig. 4.1



Assemble the parts as shown to the right.

1. Select the 180 lpm Air function and zero it.
2. Attach the 22mm tubing to the high flow OUTLET (on the back of the unit) WITHOUT the 22mm tee. Remove all connections from the high flow INLET.
3. Adjust the vacuum regulator so the display on the RT-200 shows a flowrate 10-15 lpm HIGHER than what you expect to measure.
4. Remove the 22mm tubing from the high flow outlet and attach the 22mm tee to the tubing. Select and zero the high flow N2O function. Reconnect tubing and tee to high flow outlet. DO NOT connect anything to the open port on the tee.
5. Connect the N2O source to the inlet and proceed with measurements.

Low Flow Measurements (0-5 lpm N2O)

Assemble the parts as shown above.

1. Select the 180 lpm Air function and zero it.
2. Attach the 22mm tubing to the high flow outlet (on the back of the unit). Remove all connections from the INLET.
3. Adjust the vacuum regulator so the display on the RT-200 shows a flowrate of 20 lpm $\pm$ 2.
4. Disconnect the tubing from the high flow outlet and reattach it to the scavenging bracket over the low flow OUTLET.
5. Select the 5 lpm N2O function and zero it.
6. Attach the N2O source to the low flow INLET and proceed with measurements.

4.5 HOW TO MEASURE BREATH RATE, INSPIRATORY TIME, EXPIRATORY TIME AND I:E RATIO

A. Enter a Function Code as outlined in Section 4.2. Connect the tubing to the high flow range inlet
B. Apply the flow. Cycle your ventilator or other volume producing device.
C. Read the display. The correct reading will appear on the display.
D. Rezero the unit periodically, following the procedures in Section 4.2 Step K.

NOTE: Peak-detect mode is not available on these functions. If you press the Peak/Continuous key nothing will happen.

4.6 HOW TO MEASURE INSPIRATORY TIME, EXPIRATORY TIME AND I:E RATIO ON VENTILATORS WITH HOLD MODES

A. Enter and zero a Function Code from 46-48, as outlined in Section 4.2

B. Press the F1 key. An "H" will appear on the display, indicating that you've selected the inspiratory hold mode.

C. Connect the tubing to the high range flow inlet. Connect a test lung to the outlet on the back of the RT-200. A test lung must be used to provide reverse flow through the unit during the expiratory cycle to allow the inspiratory hold mode to work.

D. Apply the flow. Cycle your ventilator or other volume-producing device.

E. The measurment will appear on the display. The inspiratory hold time is included in the inspiratory time.

F. Rezero the unit periodically following the procedures in Section 4.2 Step K.

4.7 HOW TO MEASURE ACCUMULATIVE TIDAL VOLUMES FOR MULTIPLE BREATHS

A. Enter and zero a Function Code as outlined in Section 4.2.

B. Press the F2 key. An "A" and a number representing the number of breaths to be accumulated will be displayed (defaults to "one breath, normal tidal volume" operation on power up).

C. To change the number of breaths to be accumulated, enter any number breaths between 1 and 10. (You must enter 3 digits. Ex: 4 breaths will be entered as 004.) Entering one breath (001) returns the RT-200 to normal tidal volume measurements. If not entered properly, the last allowable value or the default value will be displayed, and this step will have to be repeated.

D. Connect tubing to the high range flow inlet.

E. Apply the flow. Cycle your ventilator or volume-producing device.

F. The display will indicate the the accumulated tidal volume and the number of breaths measured thus far, as the ventilator cycles. After the selected number of breaths has been reached, the test halts. It can be restarted by pushing the Enter key.

G. Whenever tidal volume air or oxygen functions are entered, the RT-200 will return to the accumulate mode. To return to normal tidal volume operation, repeat step C above, entering only one breath.

4.8 CORRECTING PRESSURE, TEMPERATURE AND HUMIDITY FOR TESTING GAS FLOW AND VOLUME

The RT-200 defaults to ATP (ambient temperature and pressure) conditions on power up. STP (standard temperature and pressure) and BTPS (body temperature, ambient pressure saturated with water vapor) conditions can also be simulated. For further explanation of these conditions see "Key 0 0" on page 2-4. If you want to make measurements in conditions other than ATP follow this procedure:

A. Press the "0" key on the keypad twice. Then press the Enter key.

B. To accept the displayed choice of conditions, press the Enter key.

C. To choose another condition, press the "1" key until your choice appears in the window, then press the enter key.

D. If the condition you have selected requires you to enter the gas temperature or barometric pressure, a "t" or "P" prompt will be displayed with the last pressure or temperature value entered (or else the default values of 760mm Hg or 70°F).

E. To enter a different pressure or temperature value, use the numerical keys on the keypad, then press the Enter key. The barometric pressure must be between 500 and 800 (mm Hg) and the temperature be between 50 and 104 (°F). You must enter three digits (EX: 50°F = 050). If not entered correctly the last allowable value or the default value will be displayed, and this step will have to be repeated.

F. If the "0 0", "0 1" or "0 9" functions (see pages 2-3 through 2-5) are entered while testing is in progress, the testing will automatically be resumed after the function is entered.

G. Enter and zero the FUNCTION CODE you wish to use as outlined in Section 4.2. All applicable functions with the pressure and temperature selected above will appear briefly on the display. They will appear again if you enter a new function. If you want to check which functions are in effect at any time during measurement, simply press the Enter key and the special function display will be repeated. The special function LED on the display will also be lit whenever one or more special functions are in effect.

H. Connect tubing to the appropriate inlet fitting and apply flow.

4.9 CHANGING THE DURATION OF THE START-OF-BREATH AND END-OF-BREATH DELAYS AND THE SENSITIVITY OF THE TRIGGERING LEVEL

The RT-200 triggering delays can be modified to alleviate nuisance readings caused by ventilator valve noise. It defaults to a .05 second start-of-breath delay and a .10 second end-of-breath delay. That is, ventilator noise that occurs before the breath has been underway for .05 seconds will not affect the measurement of a breath. Also, noise that occurs less than .10 second after the end of the breath will not affect measurements. (For further explanation see page 2-5.) The flow or pressure level which the RT-200 detects as the start/stop of a breath can also be changed. To change the start or end-of-breath delay times or the triggering level, follow these procedures:

A. Press the "0" and "1" keys, then press the Enter key.

B. The current start-of-breath delay will be displayed, Ex: r050. (The "r" in the display indicates the "rising" side of the breath.) To accept the displayed delay, press the Enter key.

C. To change the delay time, enter a time between .000 and .200 using the numerical keys on the keypad (you must use three digits). Then press the Enter key. If not entered properly, the last allowable value or the default value will be displayed, and this step will have to be repeated.

D. The current end-of-breath delay time will be displayed. EX: F100. The "F" in the display indicates the falling side of the breath. To accept the displayed value, press the Enter key. If you accept this value, skip step E.

E. To change the end-of-breath delay, enter a time between .000 and .200 second using the numerical keys on the keypad (you must use three digits). Then press the enter key. If not entered properly, the last allowable value or the default value will be displayed, and this step will have to be repeated.

F. After the end-of-breath delay is properly entered, "L LO" will appear on the display. This indicates that the start and end of breath is detected at 1% of the full scale of the function being used. If you want to use this value, press enter. If you wish to use a 4% trigger value, press any number key. "L HI" will appear on the display. Press "Enter" to accept or any number key to get back to "L LO". (NOTE: For Function Codes 41-48, the triggering points are about 1.8 lpm and 7.2 lpm.

G. If the "0 0", "0 1" or "0 9" functions (see pages 2-3 through 2-5) are entered while testing is in progress, the testing will automatically be resumed after the function is entered.

H. Enter and "zero" the Function Code you wish to use as outlined in Section 4.2. All the applicable functions will appear briefly on the display. They will appear again if you enter a new Function Code. If you want to check which functions are in effect any time during measurement, simply press the Enter key. The special function LED on the display will also be lit whenever one or more special functions are in effect.

I. Connect the tubing to the appropriate inlet and apply flow. The reading will appear on the display.

J. If the start-of-breath delay is too short a "HELP r" message appears. If the end-of-breath delay is too short a "HELP F" message appears. Following these messages, the RT-200 automatically "tries again" in case the error message was caused by an external disturbance of the test set up.

4.10 THEORY OF OPERATION

This section refers to the Flow Module block diagram below, Figure 4.2. The Flow Module contains two different Flow Transducers. They produce a differential pressure proportional to the gas flow rate which passes through them. This differential is

sensed by the Transducer. The Selector Valve steers the appropriate pressure to the Transducer in response to signals from the Solenoid Valve Driver. The Solenoid Valve Driver is directed by the Controller in the Control Module.

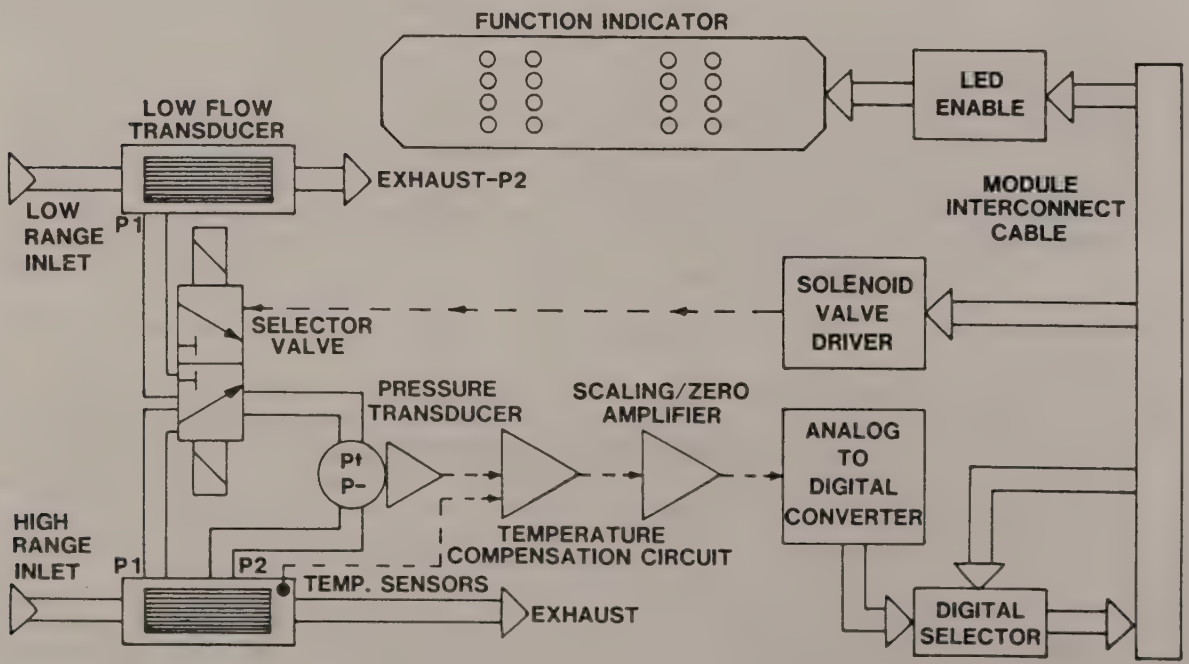
The Pressure Transducer converts the differential pressure to an electrical signal. The Temperature Compensation Circuit modifies this signal in response to information it receives from the Temperature Sensors. The signal then passes through the Scaling/Zero Amplifier to the Analog to Digital Converter, where it is converted to digital form. This data is placed on the Module Interconnect Bus for further processing by the Controller.

The High Range functions are independent of the Low Range functions. High Range readings will not be affected by flow passing through the Low Flow Transducer.

In contrast, Low Range readings will be affected by flows passing through the High Flow Transducer. When you use the Low Range flow rate functions, the RT-200 measures the pressure at P1 of the Low FLow Transducer with respect to the pressure at P2 of the High Flow Transducer (which is assumed to be at ambient pressure). However, the pressure at P2 of the High Flow Transducer will be slightly higher than ambient when flow is passing through it. The condition will result in false low readings on the Low Range flow conditions.

The Flow Module is independent of other modules in the system. Readings taken on the Flow Module will not affect (or be affected by) other measurements you are taking with a different module.

Figure 4.2



4.10.1 TIDAL VOLUME

The Controller measures tidal volumes by integrating the flow rate over the inspiratory cycle of the breath. The beginning of a breath is sensed when the flow rate exceeds the threshold level (explained in the NOTE on page 2-5). At this point the Controller begins accumulating flow rate data. When the end of the breath is reached and the flow rate falls below the threshold level, the Controller stops accumulating flow rate data and computes the tidal volume, places the result on the display and begins looking for the start of the next breath.

The RT-200 has a built-in .05 second start-of-breath delay and .10 second end-of-breath delay. These delays eliminate "false triggering" caused by ventilator noise that occurs shortly after the breath has started and after it ends. The duration of these delays can be changed by entering a special function. See Section 4.9.

4.10.2 BREATH RATE

The Controller calculates the breath rate by measuring the time from the beginning of a breath to the start of the next breath. The beginning of a breath is sensed when the flow rate exceeds the threshold level described above in the TIDAL VOLUME section above. The reciprocal of this time is computed and multiplied by the appropriate factor to yield the result in breaths per minute. The result is placed on the display at the beginning of the second breath.

4.10.3 INSPIRATORY TIME

To measure inspiratory time, the Controller computes the time between the start and finish of inhalation and displays the time at the end of the breath. If you are testing a ventilator using a hold mode, the hold time is included in the inspiratory time. See section 4.6. If inspiratory time is less than .1 second, the underrange lamp will light and the display may go blank.

4.10.4 EXPIRATORY TIME

To measure expiratory time, the Controller computes the time between the start and finish of exhalation and displays the time when the next breath begins. If you are testing a ventilator using a hold mode, the hold time is included in the inspiratory time. See section 4.6. If the expiratory time is less than .1 second the underrange lamp will light and the display may go blank.

4.10.5 I:E RATIO

The Controller computes the I:E ratio by measuring the inspiratory and expiratory time of the breath. The I:E ratio is calculated and placed on the display at the end of the expiratory cycle. The inspiratory time must be between .10 and 5 seconds. The expiratory time must be between .10 and 16 seconds. If these constraints are not met, the underrange or overrange lamp will light and the display may go blank.

4.10.6 FALSE TRIGGERING

The Controller detects the beginning and end of a breath by sensing when the flow rate crosses the threshold level (explained on page 2-5). If this occurs at any time other than the beginning or end of a breath, it is termed "false triggering." The built-in start-of-breath and end-of-breath delays in the RT-200 eliminate most false triggering. For more detail on these delays see "0 1" on page 2-5. Some causes of false triggering are:

ZERO DRIFT - Rezero the unit occasionally to prevent this.
HOSE NOISE - Do not bump or move hoses during testing.
*VENTILATOR VALVE NOISE - Delay times can often be altered to solve this problem.

* DO NOT use the delays to allow malfunctioning equipment to pass testing. Investigate and solve any abnormal pnuematic noise.

4.10.7 VOLUMETRIC FLOW RATE CORRECTIONS

If you attach any device which produces back pressure to the high flow outlet on the rear panel of the Control Module, you must apply a correction to the display readings. This correction is necessary because the RT-200 displays volumetric flow readings at the outlet pressure.

This equation corrects display readings to ROOM pressure. Tidal volume readings can be corrected to room pressure with equation E 4.3 if you can substitute volume variables for flow rate variables.

E 4.3 $Q_{act} = Q_{dis} \times (P_{out} + P_{bar})/P_{bar}$

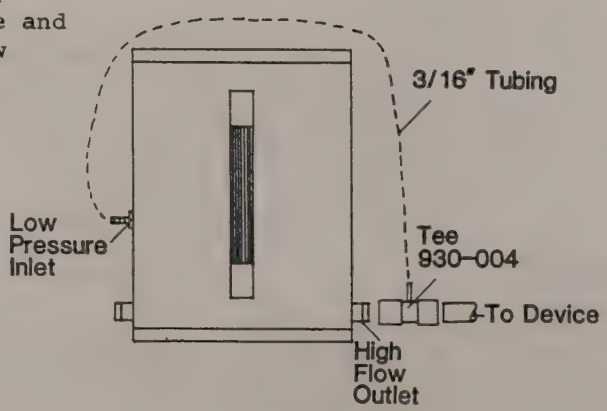
Where Q_{act} = Flow rate at room pressure

Q_{dis} = RT-200 display flow rate

P_{out} = Gauge pressure at the flow outlet.

P_{bar} = Room barometric pressure

"Pout" may be conveniently measured by attaching the tee (930-004) from the accessory pouch between the high flow outlet on the rear of the RT-200 and the device attached to the outlet. Connect a short piece of 3/16" tubing between the low pressure inlet on the pressure module and the tee attached to the high flow outlet.



31 5 lpm 02%/N2 RT-200 INSPECTION

INSPECTOR: CLW
SERIAL # M15P

TEMPERATURE 21.28
DATE: 11-02-87

INPUT	RT-200	ERROR
0.246	0.25	0.004
0.493	0.50	0.007
0.744	0.75	0.006
1.231	1.25	0.019
1.973	2.00	0.027
2.977	3.00	0.023
3.978	4.00	0.022
4.998	5.00	0.002

ACCURACY:
+/- 3 % OF READING OR +/- 2 DIGIT(S) (WHICHEVER IS GREATER) AT 70 F

+/- 5 % OF READING OR +/- 2 DIGIT(S) (WHICHEVER IS GREATER) AT 15-35 C

OVERRANGE BLANKING POINT 6.00

STANDARD CODE FOR COMPUTER INTERFACE: 36

DISPLAY UPDATE RATE: 2 PER SECOND

PEAK DETECT MODE AVAILABLE ON THIS FUNCTION

TEST REFERENCE:
PRECISION LAMINAR FLOWMETER
(0.25% OF READING)

32 5 lpm Air

RT-200 INSPECTION

INSPECTOR: CLW
SERIAL # M15P

TEMPERATURE 21.23
DATE: 11-02-87

INPUT	RT-200	ERROR
0.245	0.25	0.005
0.488	0.50	0.012
0.737	0.75	0.013
1.226	1.25	0.024
1.966	2.00	0.034
2.969	3.00	0.031
3.974	4.00	0.026
4.997	5.00	0.003

ACCURACY:
+/- 2 % OF READING OR +/- 2 DIGIT(S) (WHICHEVER IS GREATER) AT 70 F

+/- 4 % OF READING OR +/- 2 DIGIT(S) (WHICHEVER IS GREATER) AT 15-35 C

OVERRANGE BLANKING POINT 6.00

STANDARD CODE FOR COMPUTER INTERFACE: 31

DISPLAY UPDATE RATE: 2 PER SECOND

PEAK DETECT MODE AVAILABLE ON THIS FUNCTION

TEST REFERENCE:
PRECISION LAMINAR FLOWMETER
(0.25% OF READING)

33 5 lpm O2%/N2O RT-200 INSPECTION

INSPECTOR: CLW
SERIAL # M15P

TEMPERATURE 20.92
DATE: 11-02-87

INPUT	RT-200	ERROR
0.245	0.25	0.005
0.494	0.50	0.006
0.738	0.75	0.012
1.236	1.25	0.014
1.988	2.00	0.012
2.989	3.00	0.011
4.005	4.00	-0.005
4.998	5.00	0.002

ACCURACY:
+/- 3 % OF READING OR +/- 2 DIGIT(S) (WHICHEVER IS GREATER) AT 70 F

+/- 5 % OF READING OR +/- 2 DIGIT(S) (WHICHEVER IS GREATER) AT 15-35 C

OVERRANGE BLANKING POINT 6.00

STANDARD CODE FOR COMPUTER INTERFACE: 37

DISPLAY UPDATE RATE: 2 PER SECOND

PEAK DETECT MODE AVAILABLE ON THIS FUNCTION

TEST REFERENCE:
PRECISION LAMINAR FLOWMETER
(0.25% OF READING)

35 180 lpm O2%/N2 RT-200 INSPECTION

INSPECTOR: CLW
SERIAL # M15P

TEMPERATURE 21.21
DATE: 11-02-87

ACCURACY:
+/- 1 % OF READING OR +/- 1 DIGIT(S) (WHICHEVER IS GREATER) AT 70 F

+/- 2 % OF READING OR +/- 1 DIGIT(S) (WHICHEVER IS GREATER) AT 15-35 C

OVERRANGE BLANKING POINT 200.0

STANDARD CODE FOR COMPUTER INTERFACE: 46

DISPLAY UPDATE RATE: 2 PER SECOND

PEAK DETECT MODE AVAILABLE ON THIS FUNCTION

THIS PARAMETER IS DERIVED MATHEMATICALLY FROM THE FUNCTION 180 lpm Air

36 180 lpm Air RT-200 INSPECTION

INSPECTOR: CLW
SERIAL # M15P

TEMPERATURE 20.94
DATE: 11-02-87

INPUT	RT-200	ERROR
5.08	5.0	-0.08
10.00	10.0	0.00
19.99	20.0	0.01
29.90	30.0	0.10
49.89	50.0	0.11
74.87	75.0	0.13
119.68	120.0	0.32
179.35	180.0	0.65

ACCURACY:
+/- 1 % OF READING OR +/- 1 DIGIT(S) (WHICHEVER IS GREATER) AT 70 F

+/- 2 % OF READING OR +/- 1 DIGIT(S) (WHICHEVER IS GREATER) AT 15-35 C

OVERRANGE BLANKING POINT 200.0

STANDARD CODE FOR COMPUTER INTERFACE: 41

DISPLAY UPDATE RATE: 2 PER SECOND

PEAK DETECT MODE AVAILABLE ON THIS FUNCTION

TEST REFERENCE:
PRECISION LAMINAR FLOWMETER
(0.25% OF READING)

INSPECTOR: CLW
SERIAL # M15P

TEMPERATURE 21.21
DATE: 11-02-87

ACCURACY:
+/- 2 % OF READING OR +/- 2 DIGIT(S) (WHICHEVER IS GREATER) AT 70 F

+/- 4 % OF READING OR +/- 2 DIGIT(S) (WHICHEVER IS GREATER) AT 15-35 C

OVERRANGE BLANKING POINT 24.0

STANDARD CODE FOR COMPUTER INTERFACE: 47

DISPLAY UPDATE RATE: 2 PER SECOND

PEAK DETECT MODE AVAILABLE ON THIS FUNCTION

THIS PARAMETER IS DERIVED MATHEMATICALLY FROM THE FUNCTION 180 lpm Air

41 3 lit. O2%/N2 RT-200 INSPECTION

INSPECTOR: CLW
SERIAL # M15P

TEMPERATURE 21.21
DATE: 11-02-87

ACCURACY:
+/- 1 % OF READING OR +/- 1 DIGIT(S) (WHICHEVER IS GREATER) AT 70 F

+/- 2 % OF READING OR +/- 1 DIGIT(S) (WHICHEVER IS GREATER) AT 15-35 C

OVERRANGE BLANKING POINT 3.60

STANDARD CODE FOR COMPUTER INTERFACE: 55

VOLUMES WILL MEET ACCURACY CLAIMS IF FLOWRATE IS BETWEEN 10 & 120 LPM

THIS PARAMETER IS DERIVED MATHEMATICALLY FROM THE FUNCTION 3 lit. Air

42 3 lit. Air RT-200 INSPECTION

INSPECTOR: CLW
SERIAL # M15P

TEMPERATURE 21.74
DATE: 11-02-87

INPUT	RT-200	ERROR
0.272	0.27	-0.002
0.705	0.70	-0.005
1.075	1.08	0.005
1.445	1.44	-0.005
1.814	1.81	-0.004
2.184	2.18	-0.004
2.560	2.56	0.000

ACCURACY:
+/- 1 % OF READING OR +/- 1 DIGIT(S) (WHICHEVER IS GREATER) AT 70 F

+/- 2 % OF READING OR +/- 1 DIGIT(S) (WHICHEVER IS GREATER) AT 15-35 C

OVERRANGE BLANKING POINT 3.60

STANDARD CODE FOR COMPUTER INTERFACE: 51

VOLUMES WILL MEET ACCURACY CLAIMS IF FLOWRATE IS BETWEEN 10 & 120 LPM

THIS PARAMETER IS DERIVED MATHEMATICALLY FROM THE FUNCTION 180 lpm Air

43 Minute 02%/N2 RT-200 INSPECTION

INSPECTOR: CLW
SERIAL # M15P

TEMPERATURE 21.21
DATE: 11-02-87

OVERRANGE BLANKING POINT 100

STANDARD CODE FOR COMPUTER INTERFACE: 57

VOLUMES WILL MEET ACCURACY CLAIMS IF FLOWRATE IS BETWEEN 10 & 120 LPM

ACCURACY: ERROR IS A SUM OF INDIVIDUAL ERRORS ON TIDAL VOLUME AND BREATH RATE TAKEN AS A PERCENT OF READING

TEST REFERENCE:
HEWLETT PACKARD MODEL 5308A TIMER/COUNTER
(.03% OF READING)

45 Rate bpm

RT-200 INSPECTION

INSPECTOR: CLW
SERIAL # M15P

TEMPERATURE 21.21
DATE: 11-02-87

INPUT	RT-200	ERROR
101.20	101.2	0.00
5.00	5.0	0.00
180.20	180.8	0.60

ACCURACY:
+/- .5 % OF READING OR +/- 1 DIGIT(S) (WHICHEVER IS GREATER) AT 70 F

+/- .5 % OF READING OR +/- 1 DIGIT(S) (WHICHEVER IS GREATER) AT 15-35 C

OVERRANGE BLANKING POINT 210.0

STANDARD CODE FOR COMPUTER INTERFACE: 58

PEAK FLOWRATE MUST BE AT LEAST 5-7 LPM FOR THIS FUNCTION TO TRIGGER PROPERLY

TEST REFERENCE:
HEWLETT PACKARD MODEL 5308A TIMER/COUNTER
(.03% OF READING)

46 T inspiratory RT-200 INSPECTION

INSPECTOR: CLW
SERIAL # M15P

TEMPERATURE 21.21
DATE: 11-02-87

INPUT	RT-200	ERROR
0.3930	0.393	0.0000
1.2000	1.202	0.0020
5.0000	5.002	0.0020

ACCURACY:
+/- .5 % OF READING OR +/- 3 DIGIT(S) (WHICHEVER IS GREATER) AT 70 F

+/- .5 % OF READING OR +/- 3 DIGIT(S) (WHICHEVER IS GREATER) AT 15-35 C

OVERRANGE BLANKING POINT 10

STANDARD CODE FOR COMPUTER INTERFACE: 5A

PEAK FLOWRATE MUST BE AT LEAST 5-7 LPM FOR THIS FUNCTION TO TRIGGER PROPERLY

TEST REFERENCE:
HEWLETT PACKARD MODEL 5308A TIMER/COUNTER
(.03% OF READING)

47 T expiratory RT-200 INSPECTION

INSPECTOR: CLW
SERIAL # M15P

TEMPERATURE 21.21
DATE: 11-02-87

INPUT	RT-200	ERROR
0.200	0.20	0.000
10.800	10.80	0.000

ACCURACY:
+/- .5 % OF READING OR +/- 1 DIGIT(S) (WHICHEVER IS GREATER) AT 70 F

+/- .5 % OF READING OR +/- 1 DIGIT(S) (WHICHEVER IS GREATER) AT 15-35 C

OVERRANGE BLANKING POINT 100

STANDARD CODE FOR COMPUTER INTERFACE: 5B

PEAK FLOWRATE MUST BE AT LEAST 5-7 LPM FOR THIS FUNCTION TO TRIGGER PROPERLY

TEST REFERENCE:
HEWLETT PACKARD MODEL 5308A TIMER/COUNTER
(.03% OF READING)

48 I:E ratio

RT-200 INSPECTION

INSPECTOR: CLW
SERIAL # M15P

TEMPERATURE 21.21
DATE: 11-02-87

INPUT	RT-200	ERROR
1: 0.510	1: 0.51	0.000
1: 9.000	1: 9.00	0.000

ACCURACY:
+/- .5 % OF READING OR +/- 1 DIGIT(S) (WHICHEVER IS GREATER) AT 70 F

+/- .5 % OF READING OR +/- 1 DIGIT(S) (WHICHEVER IS GREATER) AT 15-35 C

OVERRANGE BLANKING POINT 1:10

STANDARD CODE FOR COMPUTER INTERFACE: 5C

PEAK FLOWRATE MUST BE AT LEAST 5-7 LPM FOR THIS FUNCTION TO TRIGGER PROPERLY

TEST REFERENCE:
HEWLETT PACKARD MODEL 5308A TIMER/COUNTER
(.03% OF READING)

IMPORTANT NOTICE

The RT-200 has been carefully designed to provide maximum accuracy and stability on the test functions provided. Each component in the device contributes to the unit's ability to maintain this accuracy. It is for this reason we recommend that most service and repair work be referred to the factory. Many repair and service procedures will change the calibration of the RT-200, especially those which involve changing or replacement of parts.

Unauthorized service during the warranty period may, at the sole discretion of Timeter, render the warranty void.

The service procedures described in this section, if performed carefully, will not affect the calibration of the unit. Please note, however, that you should receive factory authorization to proceed with these procedures during the warranty period.

HELP MESSAGES

Various error conditions can occur during the use of the RT-200. These errors generate "HELP" messages on the display. "HELP" messages give an indication of the cause of the problem, and are therefore, helpful in its solution. The messages which may occur, along with their meanings, are listed below:

Display Message	Meaning
HELP o	Zero key was pushed while there was flow or pressure applied to the RT-200. Remove the source of flow or pressure and restart the zeroing by pressing the Zero key again.
HELP E	A computational error occurred in the RT-200. This message should never occur. If it does, document the conditions that produced the HELP message and contact the factory for assistance.
HELP r	Difficulty triggering at the start of a pressure or flow cycle. Start-of-breath delay expired while ventilator noise still present. RT-200 automatically "tries again" in case the problem was caused by a test set-up vibration or similiar irregularity. See note on page 2-5.
HELP F	Difficulty triggering at the end of a pressure or flow cycle. End-of-breath delay expired while ventilator noise still present. RT-200 automatically "tries again" in case the problem was caused by a test set-up vibration or similiar irregularity. See note on page 2-5.

TROUBLESHOOTING

This section lists a number of problems you may encounter, their probable causes, and remedies you can use to solve them. If you encounter a problem not addressed here, call Timeter and ask for "RT-200 Service." Phone us at (800) 233-0258. In Pennsylvania, call COLLECT (717) 569-2695.

6.1 SYSTEM WILL NOT OPERATE

Display is dark, no function indicator lamps lit.

Possible Cause	Solution
System not plugged in	Plug system in.
System not turned on	Turn system on. Power switch is located on the rear of the Control Module.
Fuse blown	Unplug power cord. Replace fuse with same type and rating.
Hardware fault	Proceed to Control Module trouble shooting chart.

6.2 "E _ _" PROMPT DOES NOT APPEAR

Display shows strange characters or no characters.

System error resulting from a power line transient or static electricity.	Turn the power off, wait 2 seconds, then turn the power on again.
Hardware fault	Proceed to Control Module troubleshooting chart.

6.3 DISPLAY WILL NOT CHANGE

RT-200 is in peak-detect mode	Switch unit back to continuous mode by pressing the Peak/Continuous key.
System error resulting from a power line transient or static electricity	Turn the power off, wait 2 seconds, then turn the power on again.
Hardware fault	Proceed to Control Module troubleshooting chart.

6.4 RT-200 WILL NOT RESPOND TO COMMANDS FROM KEYPAD

Display may appear to operate correctly.

Possible Cause	Solution
System error resulting from a power line transient or static electricity	Turn the power off, wait 2 seconds, then turn the power on again.
Hardware fault	Proceed to Control Module troubleshooting chart.

6.5 FALSE LOW READINGS ON THE LOW FLOW RATE FUNCTIONS

Flow is passing through the high flow transducer	Remove hose from the high flow range inlet.
Outlet blocked	Free the low flow outlet.
Hardware fault	Proceed to Control Module troubleshooting chart.

6.6 FALSE READINGS ON HIGH FLOW RATE OR VOLUME

The RT-200 appears to be operating correctly, but the readings are higher or lower than expected.

Actual flow is of the wrong gas for the function you are using	Select the appropriate function.
The flow or volume you are measuring is calibrated at different conditions than you have selected. (ATP, BTPS or STP)	Select the appropriate function.
Hardware fault	Proceed to Control Module Troubleshooting chart.
Leaks in test set up	Fix leaks
The unit under test is being affected by the test set-up, incorrect test lung, etc.	Refer to the Manuals of the equipment being calibrated, for proper test "loads"

TROUBLESHOOTING CHARTS

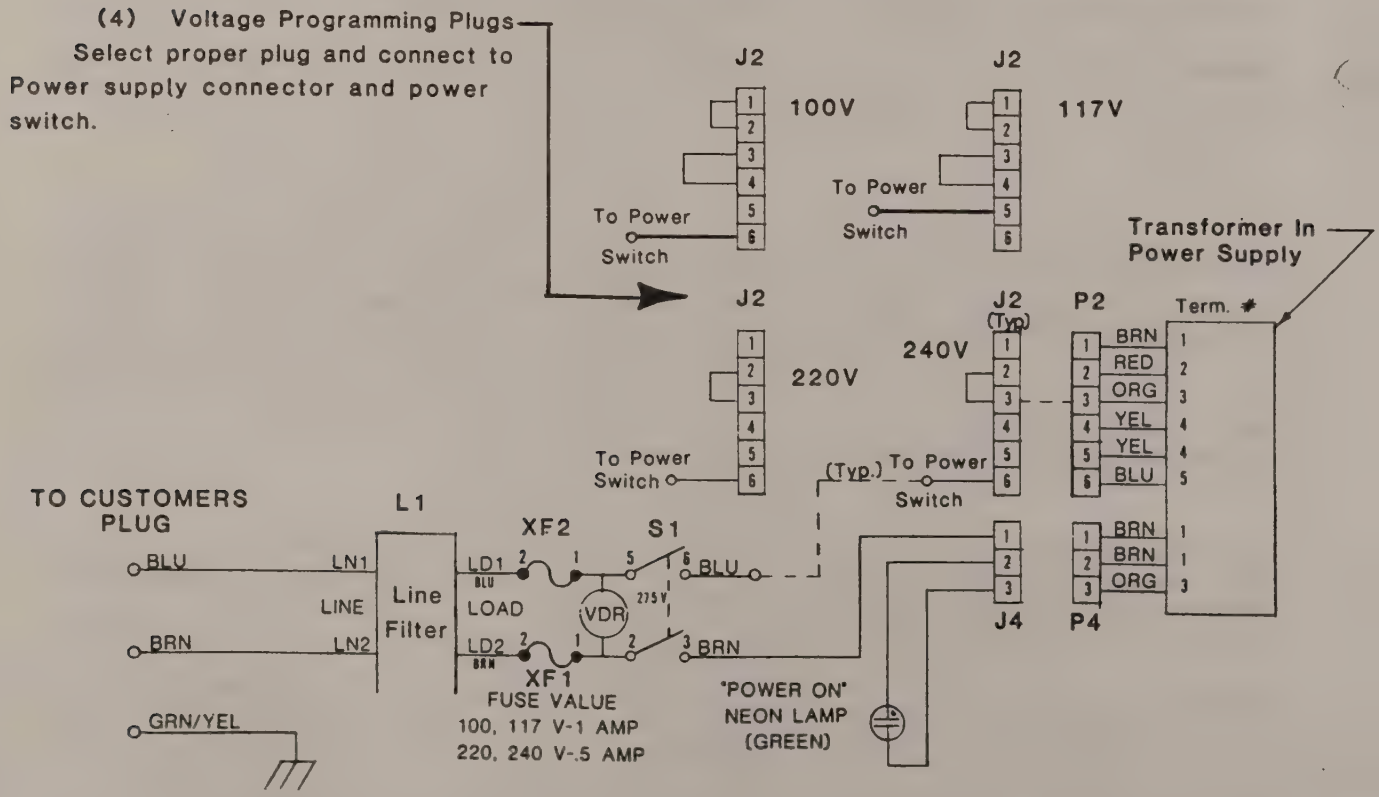
The charts on the following pages will allow you to fix hardware faults or isolate them to one module. If you have eliminated the possibility that your problem is caused by an application error (by using the TROUBLESHOOTING section), go to the Control Module troubleshooting chart.

First, remove the cover of the Control Module and turn the unit on. Allow it to warm up for a few minutes. Follow the troubleshooting chart, 7.2. If this chart directs you to another module troubleshooting chart, you must unthread the screws which secure that module to take measurements or make adjustments.

When you have isolated the problem, refer to the SERVICE section for instructions on how to return modules to the factory for repair. If you find a Control Module fault, return the entire unit to Timeter.

Contact Timeter with any further questions. Call COLLECT in PA (717) 569-2695 or (800) 233-0258 and ask for RT-200 Service.

Figure 7.0 Export Wiring



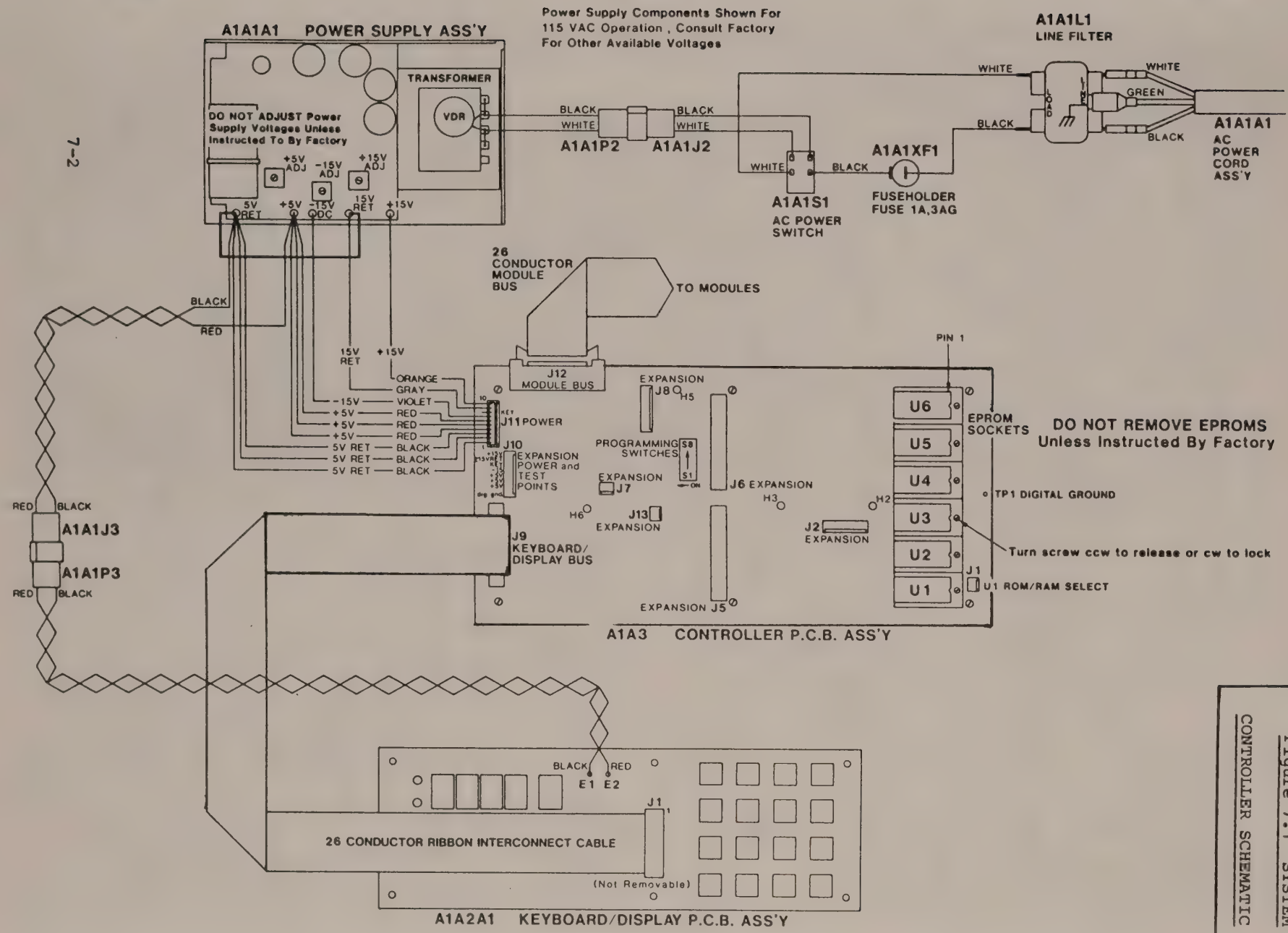
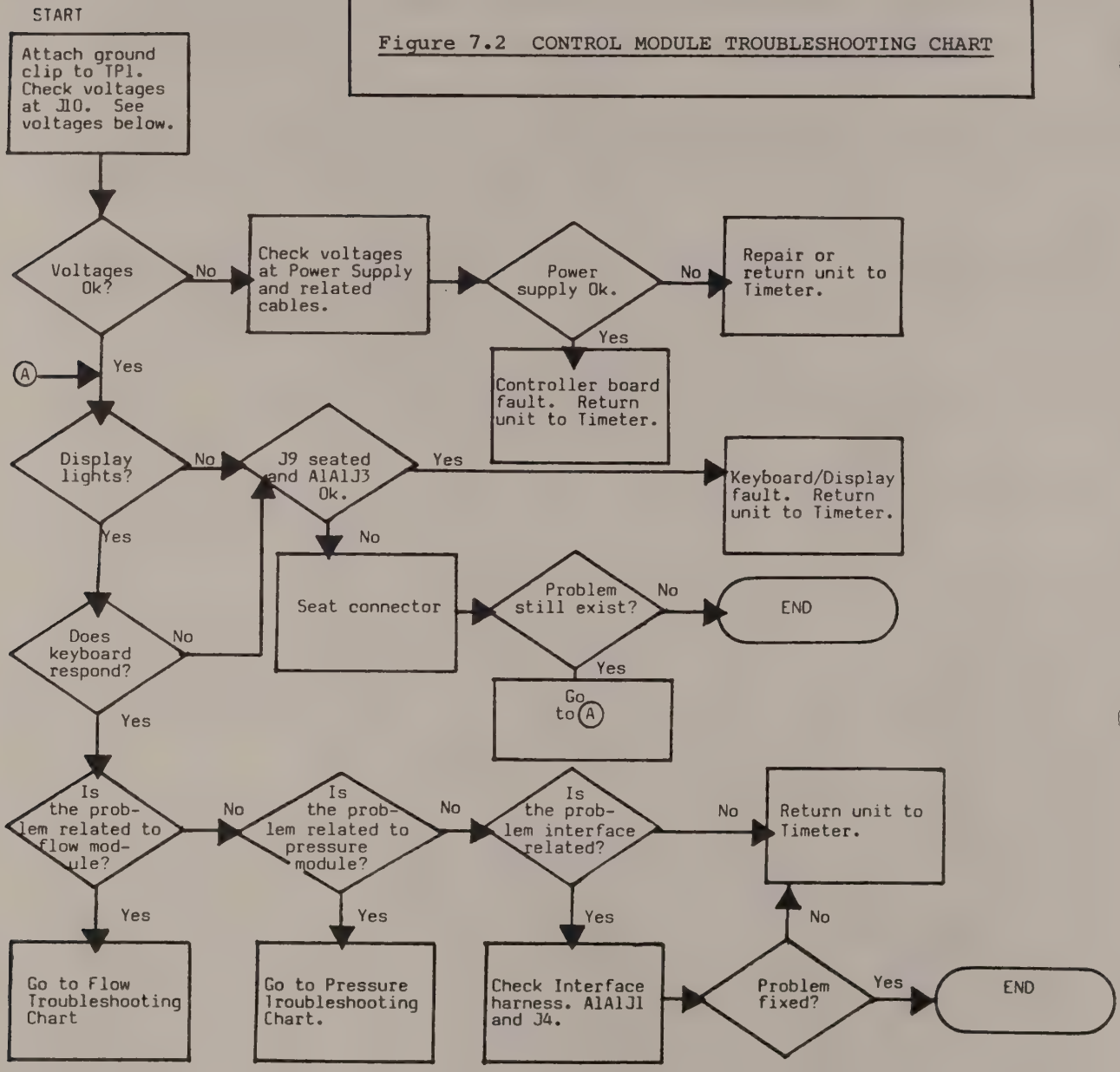


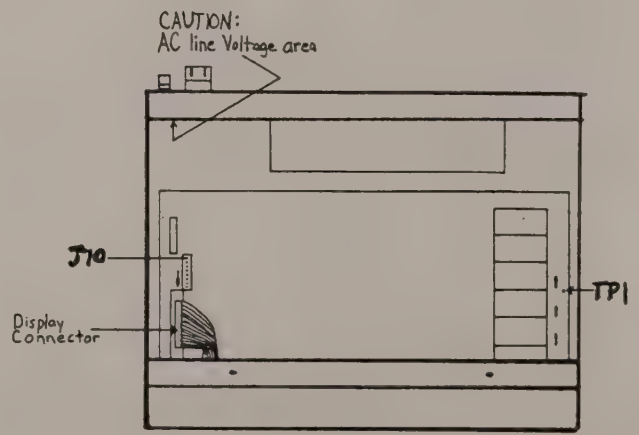
Figure 7.1 SYSTEM CONTROLLER SCHEMATIC

Figure 7.2 CONTROL MODULE TROUBLESHOOTING CHART



Power supply voltages

Nominal Voltage	Tolerance
+15.2	±0.2
-15.2	±0.2
+ 5	±0.2



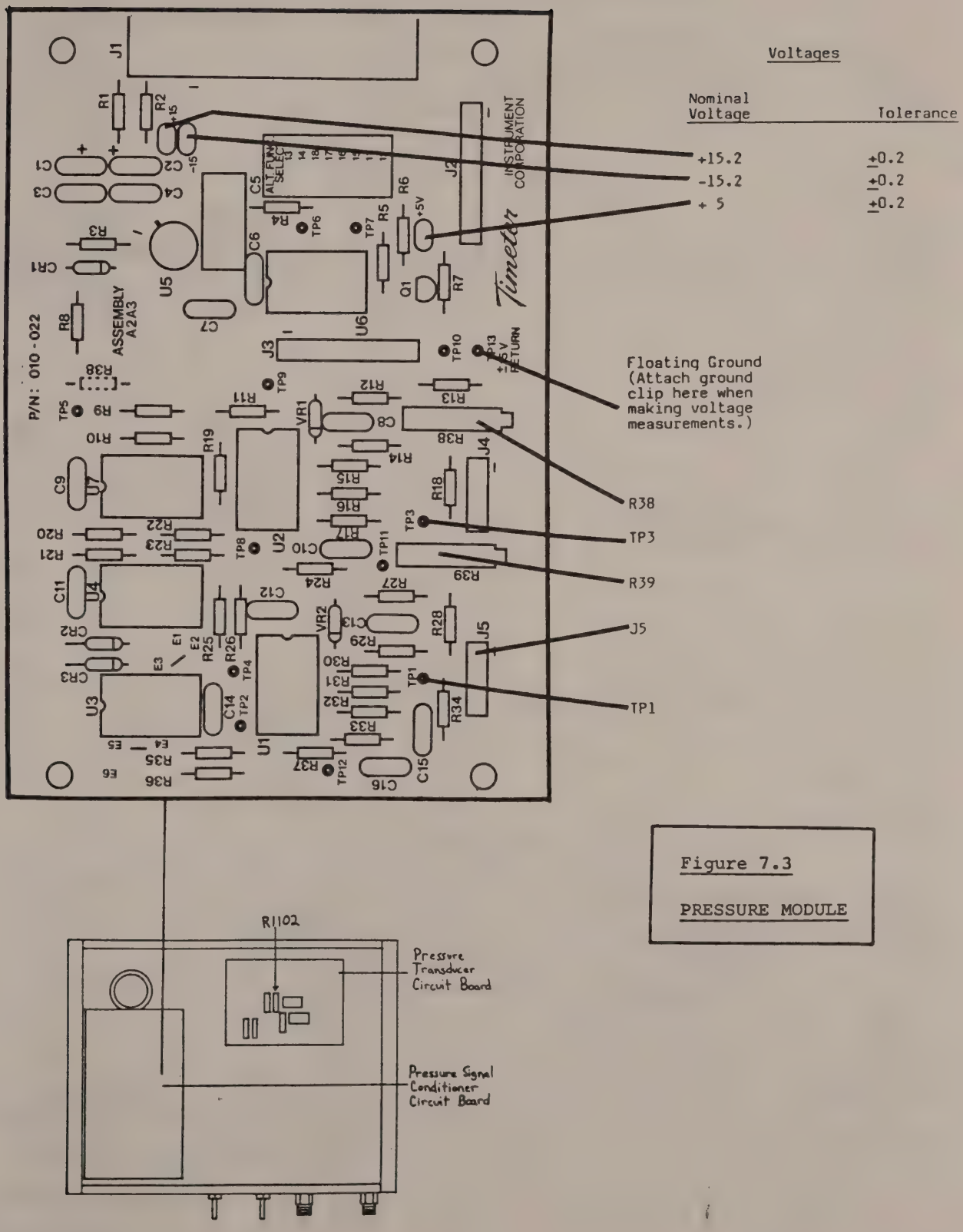


Figure 7.3

PRESSURE MODULE

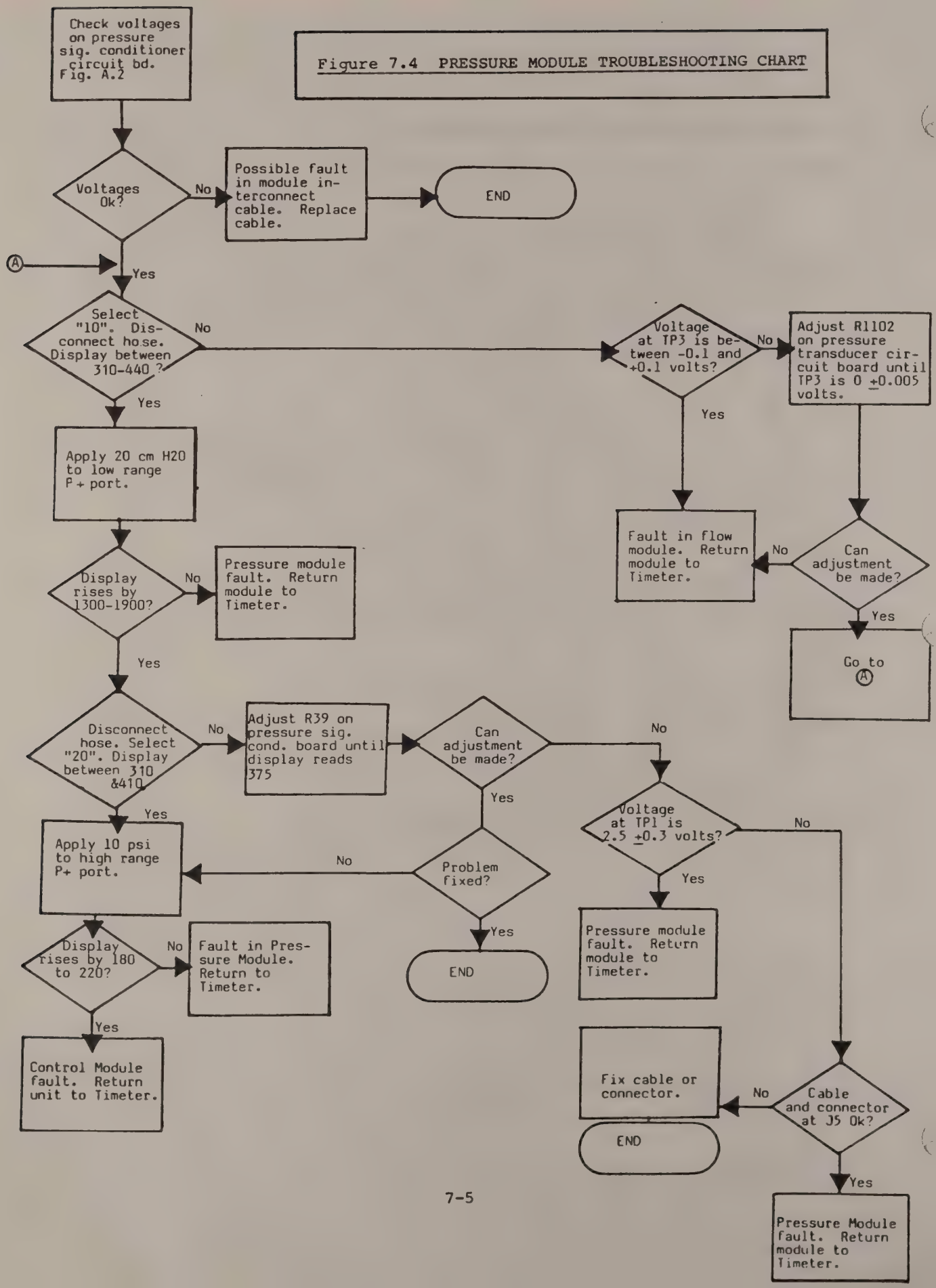


Figure 7.4 PRESSURE MODULE TROUBLESHOOTING CHART

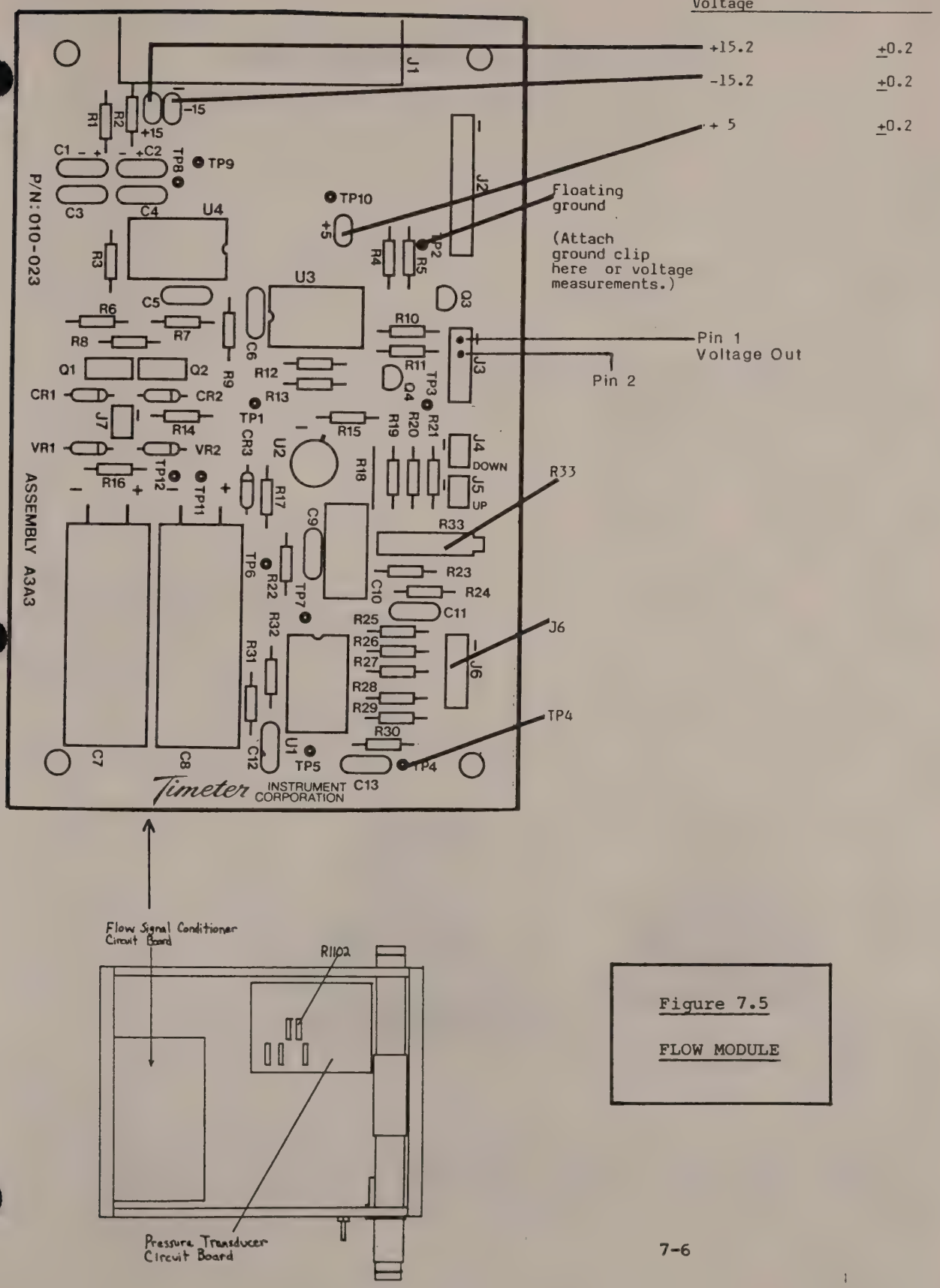
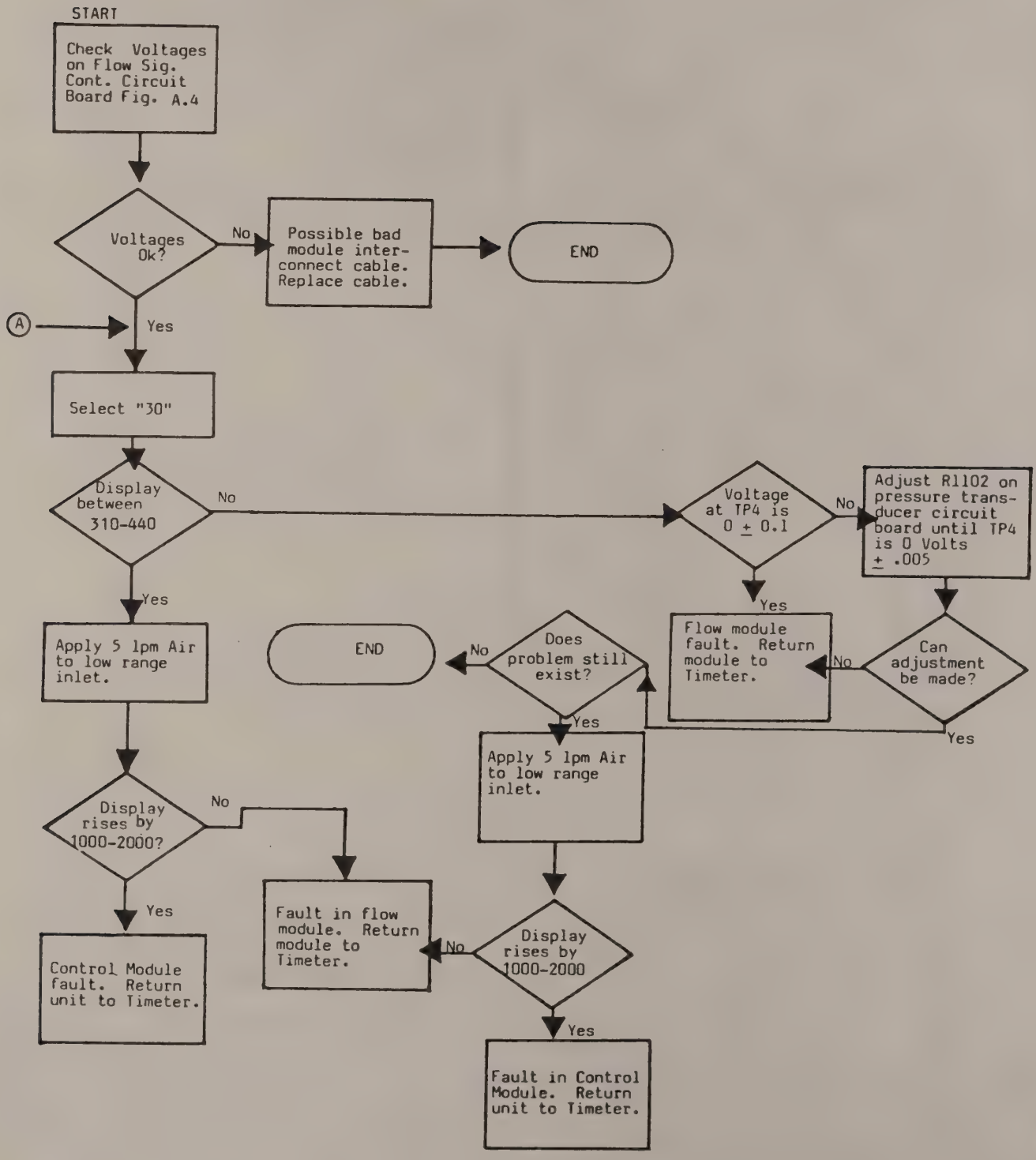


Figure 7.5

FLOW MODULE

Figure 7.6 FLOW MODULE TROUBLESHOOTING CHART



8.1 HOW TO REMOVE AND RETURN THE FLOW MODULE FOR SERVICE

1. Unplug the RT-200 power cord.
2. Remove the screws that fasten the flow module to the rest of the unit (item 1, Figure 8.1).
3. Disconnect the Module Interconnect Cable from the flow signal conditioner circuit board. Pull the latches away from the header housing to release the conncector (see Figure 8.2).
4. Feed the excess interconnect cable up into the hole in the bottom of the Pressure Module.
5. Remove the cover of the Control Module.
6. Refer to Figure 7.1 and locate the Flow Module EPROM (U5). Have a piece of aluminum foil or conductive foam on which to set the EPROM after removing it. Using a small-bladed screwdriver, release the EPROM by turning the socket locking screw 1/4 turn counterclockwise. Touch the chassis of the Control Module with your hand to discharge any static potential you may have, Carefully lift the EPROM from the socket and place it on the foil or conductive foam.

Figure 8.1

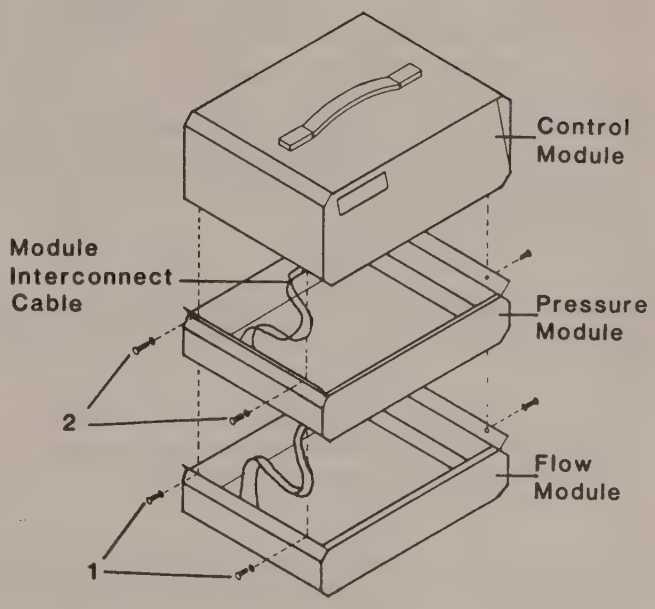
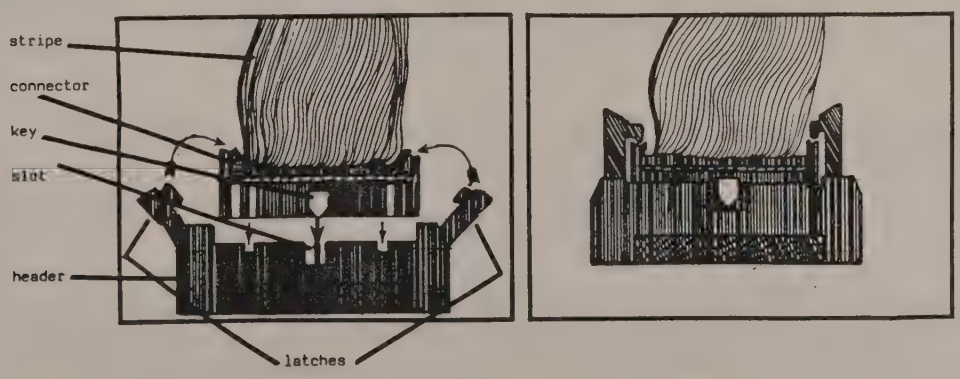


Figure 8.2



7. Pack the Flow Module and the EPROM in a suitable shipping carton and return them to Timeter (See section 1.6 for shipping instructions). You may continue to use the RT-200. If you try to select any of the flow, tidal volume or time functions, the RT-200 will disregard your selection and place the "E _ _" prompt on the display.

8.2 HOW TO INSTALL THE FLOW MODULE IN THE RT-200 SYSTEM

1. Unplug the RT-200 power cord.

2. Reach through the hole in the bottom of the Pressure Module and pull the end of the Module Innterconnect Cable down. You may have to remove the Pressure Module to retrieve the cable.

3. Locate the next-to-last connector on the cable. The last connector on the cable is reserved for future expansion, and should be folded and secured with an elastic band (see Figure 8.1). Note the key on one side of the connector (see Figure 8.2).

4. Install the connector into the header on the flow signal conditioner circuit board. The key on the connector mates with the slot on the top of the header (see Figure 8.2). When the connector is installed, engage the latches to lock it in place.

5. Place the Control and Pressure Modules on top of the Flow Module. Make sure the the Module Interconnect Cable is routed as shown in Figure 8.1. Fasten the Flow Module to the rest of the unit with four #6-32 X 5/16 machine screws and lock washers.

6. Remove the cover of the Control Module and locate the socket for the Flow Module EPROM (U5). Discharge any static potential you may have by touching the Control Module chassis. Install the flow EPROM in the proper socket with the notched end next to the socket locking screw. Lock the EPROM in place by turning the locking screw 1/4 turn clockwise. Replace the cover and verify that the RT-200 operates correctly.

8.3 HOW TO REMOVE AND RETURN THE PRESSURE MODULE FOR SERVICE

1. Unplug the RT-200 power cord.

2. Remove the screws that fasten the Pressure Module to the rest of the unit (item 2 Figure 8.2).

3. Remove the screws that fasten the cover to the Control Module and lift off the cover.

4. Locate the Module Interconnect Cable connector in the Control Module and release it from the header on the system controller circuit board (see Figure 8.1). Pull the latches away from the header housing to disengage the connector (see Figure 8.2). Push the connector down through the hole in the bottom of the Control Module.

5. Lift the Control Module off the unit and set it aside.

6. Refer to Figure 8.1 and release the Module Interconnect Cable from the header on the pressure signal conditioner circuit board. Push the connector and cable down through the hole in the bottom of the Pressure Module.

7. Lift the Pressure Module off the unit and set it aside.

8. Refer to Figure 8.1 and locate the Pressure Module EPROM (U4) in the Control Module. Have a piece of aluminum foil or conductive foam on which to place the EPROM after removing it. Using a small-bladed screwdriver, release the EPROM by turning the socket locking screw 1/4 turn counterclockwise. Touch the chassis of the Control Module with your hand to discharge any static potential you may have. Carefully lift the EPROM from the socket and place it on the foil or conductive foam.

9. Pack the Pressure Module and the EPROM in a suitable shipping carton and return them to Timeter. You may continue to use the RT-200. If you try to select any of the pressure functions, the RT-200 will ignore your selection and place the "E _ _" prompt on the display.

8.4 HOW TO REINSTALL THE PRESSURE MODULE IN THE RT-200 SYSTEM

1. Unplug the RT-200 power cord.

2. If the Control Module and Flow Modules are fastened, remove the screws and separate them. Disconnect the Module Interconnect cable from the header on the system controller circuit board in the Control Module. Push the cable down through the hole in the base (see Figure 8.1).

3. Feed the Module Interconnect cable up through the hole in the bottom of the Pressure Module. Locate the second connector from the top of the cable. Install the connector into the header on the pressure signal conditioner circuit board. The key on the connecter mates the slot on the top of the header (see Figure 8.2). When the connector is installed, engage the latches to lock it in place.

4. Set the Pressure Module on top of the Flow Module. Feed the remaining connector up through the hole in the bottom of the Control Module. Install the connector into the header of the system controller circuit board (see Figure 8.1). Set the Control Module on top of the rest of the unit.

5. Refer to Figure 8.1 and locate the socket for the Pressure Module EPROM (U4). Discharge any static potential you may have by touching the Control Module chassis. Install the pressure EPROM in the proper socket with the notched end next to the socket locking screw. Lock the EPROM in place by turning the locking screw 1/4 turn clockwise.

6. Replace the cover and fasten the modules with #6-32 X 5/16" machine screws as shown in Figure 8.1. Verify that the unit functions properly.

8.5 HOW TO CHANGE EPROMS

1. Unplug the RT-200 power cord.

2. Remove the Control Module cover.

3. Refer to Figure 8.1 and locate the EPROMs in the Control Module. Have a piece of aluminum foil or conductive foam on which to place the EPROM after removing it. Using a small-bladed screwdriver, release the appropriate EPROM by turning the socket locking screw 1/4 turn counterclockwise. Touch the chassis of the Control Module with your hand to discharge any static potential you may have. Carefully lift the EPROM from the socket and place it on the foil or conductive foam.

4. Install the new EPROM into the socket with the notched end next to the socket locking screw. Lock the EPROM into place by turning the locking screw 1/4 turn clockwise.

5. Replace the cover and secure it with fasteners removed in step 2.

NOTE: Please follow the procedure above if you obtain new or additional RT-200 software from Timeter.

8.6 USE OF THE ANALOG OUTPUT VOLTAGE SIGNAL ON THE RT-203 FLOW MODULE

Connector J3 (Figure 7.5) on the flow signal conditioner circuit board provides an analog voltage proportional to the flowrate under test. Pin 1 is the voltage signal out and Pin 2 is the floating ground. The signal at no flow is about 0.5 volts. Full scale is about 4.5 volts. The user should be aware of the following cautions and limitations when using this signal:

1. This signal is uncalibrated and unlinearized. It should be used to observe trends and wave shapes only.
2. A high input independence device should be used to record and observe this signal. (100k ohm min)
3. Attachments made to the floating ground (J3 pin 2) of the RT-200 system may introduce ground loop problems. Inaccurate display readings on some or all function modes can result. DO NOT attach a chassis or earth ground to J3 pin 2.
4. The frequency response of the voltage signal is approximately 30 Hz.

Please contact Timeter for any further information regarding this signal.

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